The University of Chicago

NEGAUNEE, MICHIGAN: AN URBAN CENTER DOMINATED BY IRON MINING

A DISSERTATION SUBMITTED TO THE
GRADUATE FACULTY IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOGRAPHY

By
JOE RUSSELL WHITAKER

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NEGAUNEE, MICHIGAN: AN URBAN CENTER DOMINATED BY IRON MINING[1]

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I. The Landscape

Cultural and Physical Features

Negaunee, Michigan, impresses the observer with the complexity of its landscape. The journey of one mile required to cross the city from north to south reveals an amazing variety of landscape forms for so short a distance—wooded hills and a sparkling lake; tall shaft heads towering above long piles of red iron ore, and open-pit mines overgrown with trees; palatial homes set in well-kept lawns, and abandoned cottages around which cows are grazing; carefully tilled flats and barren rocky slopes; gravel pits and boulder-strewn fields. The contrast between such dissimilar forms is accentuated by the abruptness of the transition from one to another. Sandy flats terminate sharply against rock cliffs, a wooded hill penetrates to within a few yards of the commercial district, and the best residential area adjoins idle land which is scarred by partly demolished foundations and abandoned streets. The landscape is further complicated by the irregular distribution of the features. Streets trend in all directions, iron mines appear in the most unexpected places, and even the land forms seem to be arranged in haphazard fashion.

If Negaunee is viewed from the top of Lucy Hill, half a mile south of the commercial district, many of the detailed variations

[1] This discussion of Negaunee is based upon field work and a study of library sources during the years 1927-30, a period of great importance in the evolution of the city. For aid in gathering essential data, the writer is particularly grateful to R. A. Brotherton and L. Merwin of Negaunee, and to F. W. Armstrong and J. E. Jopling of Marquette. Professor Harlan H. Barrows of the University of Chicago and Mrs. J. Russell Whitaker gave valuable assistance in the writing of the manuscript. Owing to lack of space, the original paper has been abbreviated by the omission of 66 maps and photographs, many of the footnotes, and the bibliography.

may not be seen, and one's attention is arrested by the general pattern of the landscape. The pictures in Figure 1 were taken from this hill top. They disclose the location of the central part of the city on a small plain which is limited on the north, west, and south by wooded hills. The city stands so close to one edge of the plain, however, that it encroaches on the hills to the west; on the north and east, the plain extends a mile or two beyond the urban complex. The outer margin of the built-up area is extremely irregular, with prominent extensions to the west, the east, and the southeast. More or less in line with these arms are isolated groups of houses, or "locations," one of which can be seen in the right foreground of the picture in Figure 1a. The central part of the built-up area is likewise irregular. The commercial district ("BBB," Fig. 1) does not occupy a central position within it, but lies on one flank, and the rectangular street pattern typical of most American cities built on nearly level plains seems to be lacking.

As the attention of the observer on Lucy Hill shifts from the built-up area to the land surrounding it, his eye is drawn to the group of shaft mines on the eastern margin of the city. Three shaft heads stand near the edge of the Negaunee plain, overlooking a small, flat-floored valley (Fig. 1a). Occupying a portion of the valley is another mine, just beyond the right-hand margin of the picture. The valley is fretted with a network of railroads. Some of them lead to the shaft mines, whereas others prove, on closer scrutiny, to be idle railroad *beds* which reach out like dead roots to abandoned open pits. One of the principal lines runs westward along the foot of Lucy Hill, while another follows the main valley across the commercial district and disappears behind Jackson Hill ("JH," Fig. 1). Teal Lake and the long treeless crest of the hill which nearly hides it direct the eye back along the northern margin of the built-up area to the flat plain at the east end of the lake. Here, the belt of pastoral and agricultural land which encircles the city is widest and least interrupted by mines, roads, and barren hills.

Of all the features revealed in the photograph in Figure 1, none is more striking than the green forest line which frames the city. Unlike the varied and restricted scene which it encloses, the forest of second growth pines and hardwoods extends in great monotonous swells across successive hills as far as the eye can see. The occasional roads which pierce the forest wall direct one's attention again to the city to which they lead.

FIG. 1A.—Looking from Lucy Hill northeast across Partridge Valley to Eastern Negaunee. The flattish outwash plain on which Eastern Negaunee is located terminates in the background against ice-scoured quartzite hills.

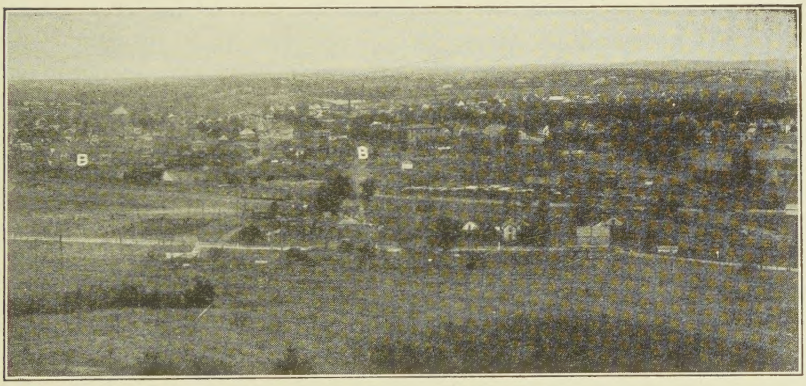


FIG. 1B.—Central Negaunee from Lucy Hill.

FIG. 1C.—Western Negaunee from Lucy Hill.

Cultural Aspects of the Geographic Divisions

Systematic mapping of the cultural features of Negaunee disclosed a great variety of landscape units, but if these are grouped according to the dominant types of land use it is necessary to recognize only five major divisions (Figure 2); (1) the residential districts, which include small areas devoted to institutional purposes; (2) the commercial district, in which there are a few scattered factories; (3) the saxicultural districts, with pastoral utilization locally important; (4) the pastoral-agricultural districts; and (5) the transportational areas, the two subdivisions of which are more properly designated as *nets* than as *districts.*

The residential districts differ widely in the character and spacing of the houses. The picture in Figure 1 shows that the dwellings in the southern part of the city are two-story, wooden buildings scattered along the roads, but the core of the residential district is obscured by trees. The aeroplane view in Figure 3 reveals this to be a flat or nearly flat area occupied by moderately large, well-kept, frame houses closely set in orderly fashion. Westward, in Partridge Valley the houses are smaller and farther apart. Eastward is a section from which the houses have been removed (Figs. 2, 4), and nearby is the new section to which they were taken (Fig. 2). Other extensions from the central district, as along Teal Lake, are similar to those previously noted. The locations present much greater variety: The one called Mary Charlotte has two rows of houses monotonously alike in size, shape, and color ("MC," Fig. 2); in the Rolling Mill location, the dwellings are small and in fair to poor repair ("RM," Fig. 2); and in the Cambria there is an odd array of modern cottages and remodeled log cabins ("CL," Fig. 2).

Except for a few small grocery stores, the commercial activities of Negaunee are localized in one district (Fig. 2). The commercial "core" is along the north side of Iron Street (Fig. 5), where the two and three-story brick buildings form a solid wall broken only by streets and alleys. The rest of the district is occupied, for the most part, by one and two-story wooden structures less closely spaced. The buildings used by the few factories—three bakeries, a creamery, a small flour mill, and a glove factory—are similar to those used for purely commercial purposes. The street scene is seldom very active; even on Saturday afternoons the streets are not crowded—a surprising feature to one accustomed to the burst

of activity which characterizes that day in many towns of the Northern Interior.

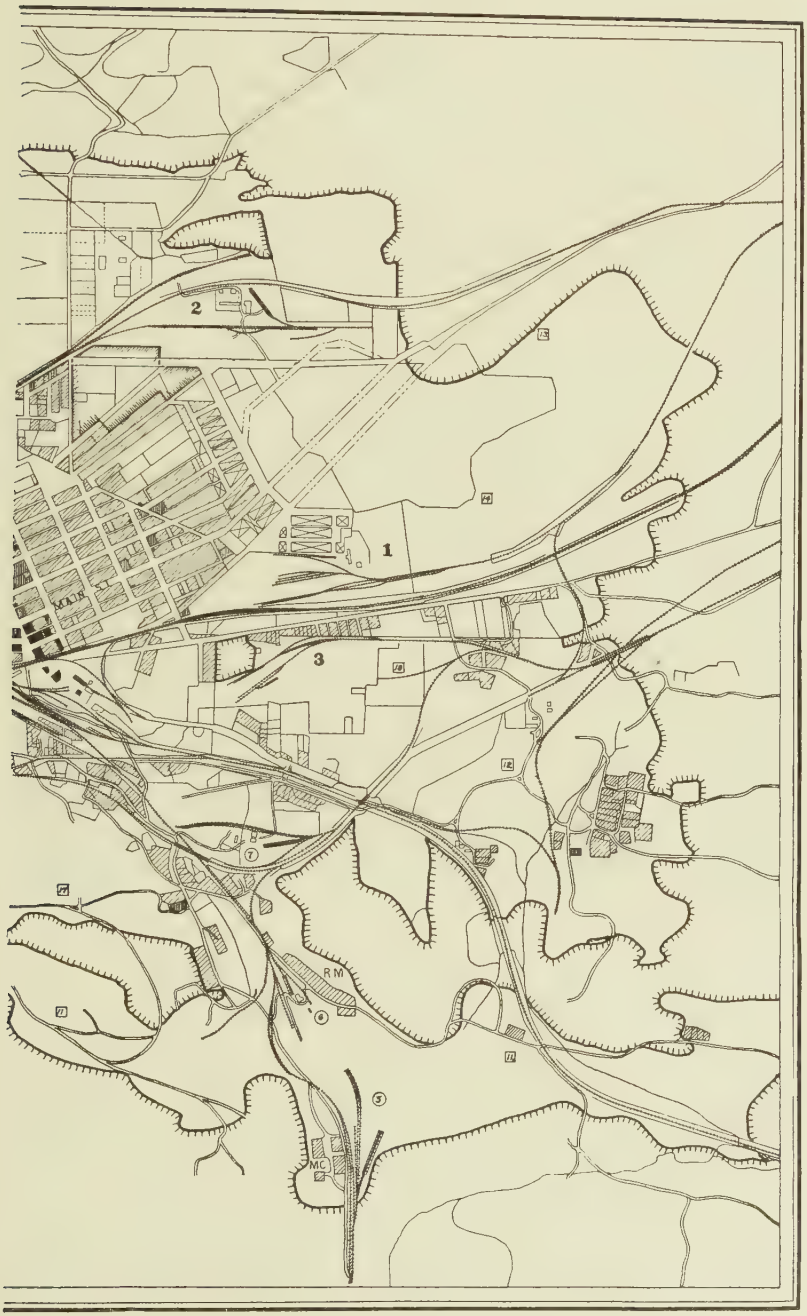
In the saxicultural districts the significant differences in the cultural landscape are determined by the kinds of mines—whether shaft or open pit, and by their condition—whether active, temporarily inactive or abandoned. Of the six possible combinations, five are found in Negaunee; active, inactive, and abandoned shaft mines, and inactive and abandoned open-pit mines. The active shaft mine type has four representatives ("1-4," Fig. 2). The more conspicuous features of the surface layout of each mine of this type are the steel shaft head and the stocking trestle and ore pile. Each of these mines has in addition a timber yard and several buildings. The inactive shaft mines ("5-7," Fig. 2) are deserted, the buildings boarded up, and the ore piles depleted (Fig. 6). The abandoned shaft mine properties have been partly or completely dismantled (Fig. 7), and except where well fenced they are used for grazing. The inactive open-pit type is represented by one small mine inconspicuously located in the southeastern part of Negaunee, but all along the southern and western margins of the city the ground is broken by many large, abandoned pits (Fig. 8) and by a multitude of small ones. Around these pits, the land not covered by piles of waste rock is commonly grazed in summer, though some of the more fertile plots have been fenced off as gardens (Fig. 6).

The peripheral pastoral and agricultural zone—which in a sense includes portions of the inactive and abandoned mine areas—is used primarily for pasture and the production of hay and oats, with only a small acreage in truck crops. Nevertheless, it appears, as is indeed the case, to be used by the inhabitants of the city rather than by farmers in the surrounding region. In summer herds of cows move daily from the city to the pastures and back again (Fig. 4); miners in high-topped boots may be seen in the hay and potato fields; and in harvest time men, women, and children are engaged in digging potatoes and carrying them cityward. This impression of unity between the urban complex and the peripheral zone of improved land is strengthened, moreover, by the penetration of the fields to the very heart of the city (Figs. 1, 2) and by the absence of outlying farmsteads to which the fields might belong.

The roads and railroads of Negaunee reveal much individual effort on the part of the builders, but little co-operative planning. The streets in the central part of the city are bituminous macadam and are well built, the main highways from the city are either

TEAL LAKE
CL
NEGAUNEE
AN IRON-MINING CITY
MARQUETTE IRON RANGE
MICHIGAN
1927-28
LAND UTILIZATION
Commercial.
Residential.
New Location 1927-28
Abandoned Residential Houses Moved 1927-28.
Institutional.
Manufactural.
Recreational.
Boundary of Cut-over Woodland Encircling the Urban Complex.
Woodland "Outliers" Within the Urban Complex.
Sylvicultural.
1 Active Mines
3 Inactive Mines
4 Abandoned Mines
(Many small workings are not indicated)
N
W
E
0
600
1200
1800
2400
FEET

FIG. 2.


2
1
MAIN
3
RM
MC

macadam or concrete, and there are no road surfaces in Negaunee which show excessive wear. The road pattern, however, is a haphazard one. The central residential district has a rectangular grill of streets with Main Street trending east-northeast and west-southwest (Fig. 2). This grill is imperfectly welded to its extensions—east of Mitchell Avenue, north of Clark Street, and west of Tobin Street—and is in marked discordance with the street pattern of the commercial district (Fig. 2). Beyond the central nucleus, the roads radiate toward the locations, the mines, and the neighboring cities. The railroads, likewise, show a notable outlay of human energy in their mileage and in their numerous cuts and fills, but they wind like great vines across the city and across one another, with little respect for the unity of the residential districts or for the continuity of the streets (Fig. 2). The superposition of this closely meshed railroad net on the haphazard street pattern is one of the more distinctive features of the landscape.

Problems of Interpretation.—In seeking to interpret the cultural forms and patterns of the geographical divisions of Negaunee, many problems appear, some of the more important of which may be suggested here. The adjustments in the residential districts to contrasted land forms, and the origin and geographic unity of the locations; the degree of dependence of the commercial life of the city on its mineral resources, and the importance of the rural trade area—its size, natural resources, and development; the relative importance of the saxicultural districts as compared to the industrial and commercial, the reasons for the presence of inactive and abandoned mines, the environmental relationships which characterize the production of iron ore in the shaft mines, and the outcome when mining comes in conflict with other uses of the land; the reasons for the utilization of the pastoral-agricultural zone by urban dwellers, and the significance of the use of these "peri-urban" districts as evidence of the agricultural possibilities of the Negaunee trade area; the origin of the irregular street pattern, and the development of the transportation system and the mining industry as each has reacted on the other—these are among the lines of investigation which the interpretation of the geographical divisions demands.

A satisfactory interpretation of a number of the facts encountered in the study of Negaunee forces inquiry into the geographical evolution of the city. The advantages and disadvantages of the site direct attention to the circumstances attending its selec-

tion—to the origin of the city. The residential and transportational patterns are clearly a matter of growth, and the presence of idle buildings in the commercial district suggests an earlier development beyond present requirements. The abandoned and idle mines call to mind the well-known tendency of mining communities to pass rapidly from a vigorous, boisterous youth, through maturity, to an early old age and death. What stage in this cycle has Negaunee reached? The solution of this problem is essential to a satisfactory interpretation of the present landscape, and it can be solved only by tracing the development of the mining industry from its

FIG. 3.—An aeroplane view of the Main Street section, central residential district.

inception. Finally, the population and wealth[2] of Negaunee are a measure, in a sense, of the success which man has attained in his occupation of the site, but a measure of past as well as of present achievements. To preserve one's perspective in studying the city of today it is desirable to have some conception of the momentum carried over from previous stages in its development. These are the principal reasons for sketching the historical geography of Negaunee before undertaking a detailed presentation of the geography of the present.

[2] The population of Negaunee is 6,550 (1930). The taxable property was assessed at $18,499,659 in 1926.

II. The Evolution of Negaunee

The Founding of the Settlement

Until the founding of a mining camp on the site of Negaunee shortly after the discovery of iron ore there in 1844-45, no settlement by white men had been made in the locality. It was merely a part of the fur trader's country of the Upper Lakes.[3]

The mining camp was established by a company of explorers from Jackson, Michigan.[4] The company had been organized to mine copper, silver, and gold, but while on the way to Keweenaw Peninsula the leader, P. M. Everett, met an Indian half-breed at Sault Ste. Marie who volunteered to guide him to outcrops of iron ore.[5] The explorers landed at the head of Marquette Bay and followed the Carp River (Fig. 9) inland to Teal Lake, where they searched in vain for the ore. Everett re-embarked for the Keweenaw Peninsula and there met an Indian chief who also claimed to know the location of deposits of iron ore. Under his direction, they went back to the Teal Lake area, where they discovered ore on the northwestern slope of Jackson Hill. After staking out a claim, the entire party returned to Jackson. The following summer, 1846, permanent occupation of the property began when Everett built a log cabin there and left some men to remain in charge during the coming winter. This camp marked the beginning of Negaunee.

[3] After spending a summer (1840) in exploratory work in the Lake Superior region, Bela Hubbard wrote that the American Fur Company had three trading posts on Lake Superior—at Sault Ste. Marie, L'Anse, and La Pointe. He added that "These were the only white settlements on the southern shore of this great lake." Fuller, G. N., ed., *Geological Reports of Douglass Houghton,* 1837-1845, (Lansing, 1928), 42.

[4] For general accounts see Swineford, A. P., *Mineral Resources of Lake Superior* (Marquette, 1878), 95-6; Jopling, James E., "Negaunee Iron Mines," *Negaunee Iron Herald,* Nov. 10, 1923; Brooks, T. B., "Iron Bearing Rocks," *Mich. Geol. Surv.,* I, (1873) 14-19.

[5] During the preceding summer, government surveyors had discovered iron ore south of Teal Lake while running the township lines. Burt, Wm. Austin, *United States Government Field Notes,* T.47N, R.26W, 1845. (Photostat copy, Marquette County Historical Society.)

It is possible that Everett's guide learned of this discovery through the Indians employed as packers for the party, or that he himself had been with the surveyors when the ore was found.

The log cabin—no longer standing—was built near the point where ore was discovered. The claim, one square mile in extent, was located to include not only the outcrop of ore and the camp but also most of Jackson Hill. As finally drawn, the boundaries of the claim were made to conform to the lines run by the government linear survey, so that Section 1, T47, R27 became the property of the mining company.[6]

The Open-Pit Cycle;[7] *Infancy (1846-55)*

The Location.—The early years of the settlement were years of struggle and failure. Although the first cabin was built on the

FIG. 4.—Abandoned residential section in Eastern Negaunee. Foreground, partially filled basement from which the dwelling has been moved. Background, the Maas mine and quartzite ridges.

Jackson mine property in 1846, there were only six houses in the entire settlement nine years later.[8] These houses, all built of rough-hewn logs, were located near the mine which had been opened at

[6] Section 1 lies just west of Tobin street and includes most of western Negaunee (Figs. 2, 10).

[7] Each of the successive periods in the evolution of Negaunee is named for the corresponding stage of development of saxicultural occupance.

[8] Gauthier, Medard, "Reminiscences of Negaunee, 1855-1873," Manuscript, 1922, Marquette County Historical Society.

the outcrop of ore.[9] For food, the inhabitants relied chiefly on salt meat, wheat flour, dried apples, molasses, and tea; producing no crops, they were forced to fall back on these relatively imperishable foodstuffs, supplemented, doubtless, by fish and wild game from Teal Lake basin. For employment, they depended directly or indirectly on the mine and on a forge where iron blooms were made.

The Open-Pit Mine.—Jackson Mine, indicated as "8" in Figure 2, began as little more than a crude quarry. Because of the ice-scoured condition of Jackson Hill there was little or no cover to be removed. The ore was pried loose with bar and pick, and broken up into smaller pieces with a sledge. Horse carts were used to remove the ore to stock piles. Little systematic mining was done prior to 1850, however, and probably at no time during this period were more than eleven or twelve men employed at the mine. Despite the small scale of the operations and the primitive methods employed, the principal obstacle to profitable mining was the lack of a satisfactory market.

Access to markets outside of Marquette County was so difficult as hopelessly to handicap any attempts in that direction. At first, the only means of transportation to the port of Marquette was by sled during the winter months. The average sled load was 3,600 pounds, and a team could make only one trip daily. The whole winter's haul scarcely exceeded a thousand tons.[10] This movement to the shipping port was only the first step in a costly journey to the receiving ports on the Lower Lakes.

At Marquette the ore was dumped on a wharf, then loaded into sailing vessels by means of wheelbarrows. At Sault Ste. Marie the ore was unloaded, carried around the rapids, and reloaded for the trip down the lakes. The first important shipment, consisting of six barrels of ore, followed this route to Detroit in 1852.[11] In September, 1853, 152 tons were shipped to Sharon, Pa., to be tested in the furnaces there. Four vessels were required to carry the ore to Sault Ste. Marie, where it was portaged and reloaded, shipped to Erie, Pa., and sent on to Sharon by canal. Such small, irregular shipments as these made up the early iron ore trade with the Lower

[9] Brook's map of Negaunee for 1872 shows a group of six houses, presumably the original cabins, standing there, but they have since been removed, and the site covered with piles of waste rock.

[10] Armstrong, W. F., "History of Transportation on the Marquette Range" (Manuscript Loaned by Author, Marquette, Mich., 1929), 4.

[11] *Ibid*, 2.

Lakes. The principal market during this period was furnished by the forges which sprang up at Negaunee itself, at Marquette, and elsewhere in Marquette County.

The Forges.—The first forge for making iron blooms in the Lake Superior region was built by the owners of the Jackson mine at a small falls on the Carp River about three miles east of the mine.[12] Power to operate the bellows was secured from the falls, the ore came from the company's mine, charcoal was prepared from local hardwoods, and the blooms were sent to Marquette for shipment. The daily product was about three tons of iron. Although

FIG. 5.—Iron Street section, commercial district.

the forge began operations in 1848 and was not abandoned until 1856, it never produced much iron for it was idle most of the time. Two other forges, one at Marquette and the other a few miles northwest of that city, were built by 1850, but like the Jackson, they were failures. The movement of machinery, supplies, and men into the area, the assembling of the ore and charcoal, and the export of the blooms—all met the handicap of costly transportation. With the opening of the Soo Canal, the manufacture of iron blooms was abandoned and regular shipments of ore were begun. By

[12] Brooks, *op. cit.*, 17-8.

that time, the forges in Marquette County had used about 25,000 tons of ore,[13] of which perhaps half came from the Jackson mine and the remainder from mines west of Negaunee.

This primitive experiment in iron smelting was significant in a number of ways. It gave a market for ore, but failed to enable the mine to operate with profit. Instead of discouraging further attempts to smelt ore, it focused attention on the need for an efficient method of manufacture and for better facilities for exporting the product. It led to forest clearing in the preparation of charcoal. And, finally, it helped to keep alive the feeble settlement at Negaunee.

Summary.—During this period, Negaunee was struggling for its life. Dependent on an infant open-pit mine and an unsuccessful forge, housed in a few log cabins set in a virgin forest, and connected with the outside world by roads which were little more than trails, the settlement lived on capital furnished by non-residents rather than on any wealth it produced.

The Open-Pit Cycle: Youth (1855-70)

Negaunee in 1868-70.—The period from 1855 to 1870 was one of remarkable growth. From a mere handful of miners, Negaunee sprang to sudden life with 300 to 500 inhabitants in 1859,[14] while by 1870 the number had increased to 3254.[15] The map in Figure 10 shows the topographic setting of the village.

The nucleus of the present city was beginning to take form. The street pattern was laid out much as it is today; the commercial district, adequate for the needs of three thousand people, was developed along Iron Street, and residences were filling in the area northeast of Iron Street. Two railroads entered the city and crossed each other in the commercial district. Westward, along a continuation of Iron Street, were the pits of the Jackson mine; and fully a mile from the center of the village—was a cluster of houses which marked the location of the original settlement. Pits likewise interrupted the steep slopes of the hills south and southwest of the village. Prominently located near the center of the village were the Pioneer furnace and a number of charcoal kilns.

[13] *Ibid*, 19.

[14] From a report by C. T. Harvey, quoted in "A Statement of the Plan of the St. Mary's Canal Mineral Land Company, N. Y.," (1859), 10.

[15] *U. S. Census*, 1870.

This prosperous village of fifteen years' growth depended, like the struggling mining camp from which it sprang, on the exploitation of its mineral and forest wealth in the mining and smelting of iron ore. How did it come about that these industries were successful where a few years earlier they had led to failure?

Growth of Transportation Facilities.—The period of prosperity was inaugurated by a series of improvements in the transportation system which connected Negaunee with the lower lake ports.

The haul of 13 miles down the rugged Lake Superior escarpment presented the first difficulty. Unsuccessful in their attempts to secure a railroad, the mining companies of Negaunee and

FIG. 6.—An inactive shaft mine. At the left foreground is a cave-in, and in the middle background a "location."

Ishpeming (a mining camp just west of Negaunee) built a plank road from Ishpeming through Negaunee to the port of Marquette.[16] Although originally planned to be an ordinary road surfaced with wooden planks, it was completed in 1855 as a tramway. Wooden rails protected by strips of iron were laid, and over them ran small mule-drawn cars. A team of mules drawing a car of four tons could make one round trip a day. The entire tonnage that could

[16] Brooks, "Iron-Bearing Rocks," *Mich. Geol. Sur.*, I, (1873), 22; Armstrong, W. F., "History of Transportation on the Marquette Range" (1929), 4-7.

be shipped on the plank road in one day was less than the capacity of a single modern ore car.

As a part of the plank road project, the mining companies erected two docks in Marquette. Here the ore was unloaded from the cars with shovels and thrown on the floor of the docks, from which it was placed in wheelbarrows and wheeled aboard the vessels. It took four days for two hundred men to load a cargo of about two hundred tons. This slow and costly method was changed two years later (1857) when the Jackson Mining Company built the first dock with ore pockets.[17] The ore could then flow by gravity from the car into the pockets where it was stored until discharged into the hold of a boat. Thus the problem presented by the change from land to water transportation was solved at a relatively early date.

The last major handicap encountered by the ore on its way to the Lower Lakes was the rapids in the St. Mary's River at Sault Ste. Marie. Without specific regard for the needs of the Lake Superior fur trade but rather as a part of a statewide plan of internal improvements, the Michigan legislature authorized the building of a Soo Canal nine years before Negaunee was founded. Although the line was surveyed, the contract let, and the work begun, the canal was never completed. In 1840, the project was revived[18]—this time to aid the Lake Superior fisheries, the output of which was estimated to be worth one million dollars annually. In advocating the scheme, only casual reference was made to the copper and iron deposits which were supposed to exist in abundance along the southern shore of the lake. The state bombarded Congress with requests for a land grant to finance the canal. Appeals were presented in 1843, 1844, 1848 and 1849. Meanwhile, the iron and copper deposits had become better known and prospectors had begun their search for ore. Supported by the "clamor of the mining interests, which had now grown insistent,"[19] and armed with cost data and construction plans prepared from a new survey of the site of the proposed canal, the state finally obtained a congressional grant of 750,000 acres of land to aid in building it.

[17] Merritt, D. H., "History of Marquette Ore Docks," Reprint from *Lake Sup. Min. Inst. Proc.* (1914) 1-2.

[18] News item in *Detroit Free Press,* 1840, quoted in Swineford, *Mineral Resources of Lake Superior* (Marquette, 1876), 17.

[19] Williams, Ralph D., *The Honorable Peter White: A Biographical Sketch of the Lake Superior Iron Country* (Cleveland, 1905), 106.

The act was passed in 1852, and late in the summer of 1855 the canal was opened for traffic.

About the time the Soo Canal was nearing completion, the construction of the railroad which the Negaunee-Ishpeming mining companies had tried to secure was finally begun. It was ready for operation in 1857. The railroad followed the same general route as the plank road from the Ishpeming mines through Negaunee to Marquette.[20] Under favorable conditions, twelve hundred tons of ore could be hauled to Marquette in a day.

These improvements in transportation were reflected immediately in lower freight rates and a greater volume of traffic via the St. Mary's River.

TABLE I[21]

SHIPMENTS OF IRON ORE, NEGAUNEE TO LAKE ERIE PORTS

Year	Rate per ton Negaunee to Marquette	Rate per ton Marquette to Lake Erie Ports	Tonnage of iron ore passing the Rapids at Sault Ste. Marie
1854	$3.00	$5.00	Irregular shipments
1855	$3.00	$5.00	1,447
1856	$1.27	$3.00	11,297
1857	$1.27	$2.67	26,184
1858	$0.87	$2.09	31,035

Although temporarily counteracted by the panic of 1857, the effect of lower freight rates on the Negaunee settlement was profound. The enlarged market for iron ore gave new life to exploration and mining,[22] the erection of the first blast furnace in the Lake Superior region at Negaunee in 1858 was the direct outgrowth of the improvements in rail and water transportation,[23] and

[20] Cleveland-Cliffs Iron Company, Map of Portion of Marquette County, ca 1867 (Mar. Co. His. Soc.).

[21] Data compiled from Foster and Whitney, "Report on the Geology and Topography of the Lake Superior Land District," *Senate Doc.* Vol. III, No. 4, *Special Sess. 32nd Cong.*, Part II, 81; Report of C. T. Harvey quoted in *"A Statement of the Plan of the St. Mary's Canal Mineral Land Company* (1859), 8; *Mineral Resources of Michigan, Mich. Geol. Survey*, 1912, 106.

[22] "The iron enterprises have only been developed since the completion of the Sault canal, three years since." *A Statement of the Plan of the St. Mary's Canal Mineral Land Company* (1859), 10.

[23] The Pioneer furnace was erected largely through the efforts of C. T. Harvey, who superintended the construction of the Soo Canal.

in three years the population of the village jumped from less than fifty inhabitants to ten times that number.

The Civil War.—These improvements in transportation had hardly made themselves felt before the rise in the prices of iron ore and iron products occasioned by the Civil War came as an additional stimulus to the Negaunee industries.[24] With the declaration of a dividend in 1862, the Jackson mine became a profit-paying enterprise for the first time in its history, and the Pioneer furnace benefited from the high price of charcoal iron.[25] Thus Negaunee entered a period of prosperous exploitation of its mineral and forest resources.

The Open-Pit Mines.—The tonnage of iron ore shipped from Negaunee grew rapidly from about 1000 tons per year at the beginning of the period to 135,000 tons in 1871. (Fig. 11).[26] In 1870 there were two mines shipping ore from Negaunee, the Jackson and the New York Hematite. The Jackson was the more important, employing some 200 to 300 men.

The New York Hematite, located on the south side of Lucy Hill, marked a new development in the local mining industry. The Jackson mine depended on hard ore, solid as the ancient crystalline rock enclosing it, whereas the New York Hematite yielded soft ore, so soft and friable as to remind one of thoroughly weathered rock. Heretofore, only the hard ores had been in demand; any soft ores mined were thrown on the waste heap or used for surfacing roads. But by 1870, the furnace operators had learned to use the soft ores, and the New York was opened to exploit them. Although important in later years, the soft ores were of little significance to Negaunee during this period, for by 1871

[24] Brooks, "Iron-Bearing Rocks," Mich. Geol. Sur., I (1873) 34; Sawyer, Alvah, *A History of the Northern Peninsula of Michigan* (Chicago, 1911), I, 426.

[25] Peter White, a pioneer of Marquette County, said that the highest prices he ever received for charcoal iron—$85, $90, and $95 per ton for "the three grades"—were obtained during war time. Mather, Wm. G., "Charcoal Iron Industry for the Upper Peninsula of Michigan," *Lake Superior Mining Institute Proceedings,* IX (1903), 73.

[26] Sources of the data used in the graph, Fig. 11. For ore shipments—*Mineral Resources of Michigan* (Conservation Department, Lansing, Mich.) 1912, 1918, 1921, 1922, 1923; Crowell and Murray, *Iron Ores of Lake Superior* (Cleveland, 1926); *Iron Trade Review,* Mar. 8, 1928. For population—*United States Census,* 1800-1930; *Census of Michigan,* 1884 and 1894; Harvey's Report in *"A Statement of the Plan of the St. Mary's Canal Mineral Land Company* (1859).

scarcely two thousand tons had been shipped as compared to more than a million tons of hard ore.[27]

Open-pit mining had a number of advantages over underground mining. The preparatory work was reduced to the "simplest and safest kind of pick and shovel, hammer and drill, horse and cart business," [28] which could be let to contractors. Large investments in sinking, drifting, and timbering were avoided. Little skilled labor was called for, and—as stated at the time—"in an isolated cold country like Marquette [County], the quality of the labor is an important consideration." In addition, underground mining was particularly difficult because of the complex rock structure. The

FIG. 7.—An abandoned shaft mine. Note the water-filled cave-ins, and, in the middle background, a "location."

intricately folded and faulted strata would have necessitated frequent changes in the method of attacking the ore; the ore deposits were thick, making timbering difficult; and soft schists, too weak to form a good roof, occurred in many places as the "hanging wall." Several attempts at underground work had been made but were unsuccessful—if the stopes could not be opened to daylight they were abandoned. The difficulties in the way of underground mining were so impressive that the state geologist predicted a critical period when open-pit mining should have to be discontinued.[29]

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[27] *Mineral Resources of Michigan,* 1912 (Lansing).

[28] Brooks, "Iron-Bearing Rocks," *Mich. Geol. Sur.* I (1873), 244ff.

[29] *Ibid,* 248.

The ore bodies were followed downward tens of feet, developing pits of irregular outline which were "anything but pleasing" in appearance. Some of the excavations actually reached a depth of 200 feet, and in some places as many as forty feet of mantle rock and an equal thickness of bed rock were stripped to get at the ore. The scattered piles of waste rock were often in the way of the miner, and some of them had to be moved two or three times to reach the underlying ore.

The Railroads.—The railroad net serving Negaunee and the adjacent mining towns expanded notably during this period.[30] The line from Marquette was extended to Champion, a mining town at the west end of the Marquette Range, by 1865, and on to Lake Superior at L'Anse in 1872. In 1854, the Chicago and Northwestern Railroad entered Negaunee from Escanaba along the Partridge Creek valley (Fig. 9). Though these railroads were of value in bringing supplies to Negaunee and taking away forest products, it is doubtful if they carried much ore, because the more direct route to the Lake Erie ports ran through Marquette.

The transport services between Negaunee and Marquette continued to suffer from climatic and topographic handicaps. As late as 1864, the railroad ceased operations with the first snows of autumn,[31] primarily because the trains were unable to cope with heavy snow in addition to the steep grades encountered in ascending the Lake Superior Escarpment. Then, as now, the return climb with empty cars determined the maximum train load to the port. Ten empty cars were all an engine could haul up to Negaunee, and even this light load was too great when the track was covered with snow. This interruption of railroad traffic did not seriously handicap the mining industry, however, for the snows also slowed up production in the open pits and ice closed the lake route to the principal markets.

The Charcoal Iron Furnaces.—This period was characterized by profitable use of iron ores in local charcoal blast furnaces.[32] In

[30] Armstrong, "History of Transportation on the Marquette Range" (1929), 9-12.

[31] Anthony, E. C., "Personal Reminiscences," *Negaunee Iron Herald,* July 13, 1923.

[32] "Beginning with war times, and while the supply of hardwood was abundant, they were very successful." Jopling, James E., "The Marquette Range, Its Discovery, Development, and Resources," *Trans. Amer. Inst. Min. Eng.* (1897).

1860, there were ten furnaces in Marquette County, and seven of them produced iron during that year.[33] Of the ten, five were closer to the Negaunee mines than to any other, but the Pioneer furnace was the only one very intimately connected with the development of Negaunee.

Like the forges which preceded it, the furnace used charcoal made from local hardwoods.[34] Although the furnace was located on the north side of Partridge Creek opposite the iron ore outcrops on Lucy Hill, it actually depended on ore brought from the Jack-

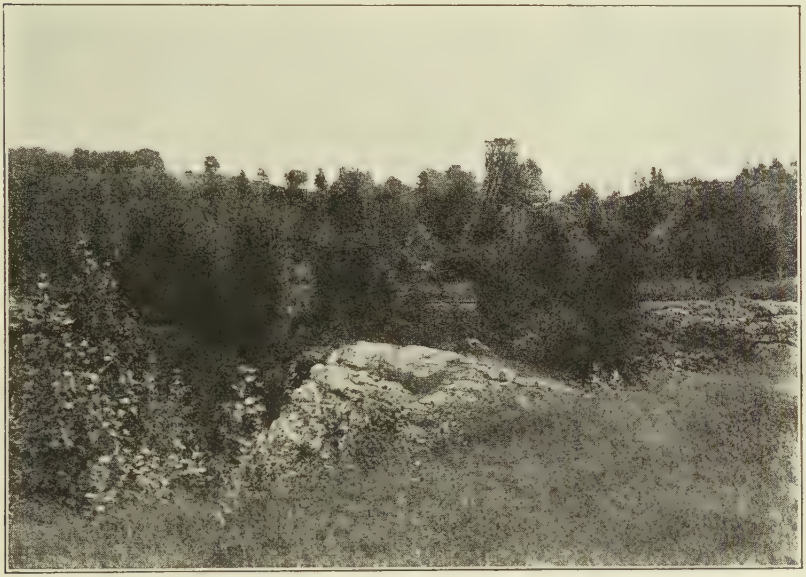

FIG. 8.—An abandoned open-pit mine.

[33] Swineford, A. P., *The Lake Superior Iron District,* (Marquette, 1869), 29.

[34] Most of the northern half of Marquette County, including Negaunee, was originally covered with a mixed forest which J. O. Veatch characterizes as follows: "On well-drained soils. *Hardwood-conifer*—Sugar maple, yellow birch, elm, basswood, with a somewhat smaller proportion of hemlock, balsam fir and white pine. On the thinner and drier stony soils and rock knobs, white pine, Norway, aspen, cedar, oaks with sugar maple, elm and yellow birch. On the poorly drained soils, *Conifer*—Spruce, cedar, tamarack on the peats. Hemlock, white pine, elm, ash, aspen in addition on mucks. Fir, hemlock, white pine, spruce, elm, ash, red maple, basswood on the mineral soils. Wet soils constitute 15 to 20 per cent of the total area." *Mich Quarterly Bulletin, Michigan State College of Agriculture and Applied Science,* X (1928) pp. 124-5, and Fig. on p. 120.

son mine a mile away and from the mines at Ishpeming. It seems that the first fluxing material came from outcrops of dolomitic marble about five miles east of Negaunee, but before long limestone was brought by rail from quarries near Lake Michigan. The furnace was erected near the railroad leading to Marquette, on ground supposed to contain no iron ore. The site seems to have been selected for two reasons—nearness to the village and the presence of a steep bluff, the edge of the flattish outwash plain of east Negaunee, against which the two stacks were built. The furnace began operations in 1858.

The importance of the furnace in the economic life of Negaunee was well illustrated when it burned in 1874, precipitating a "local panic."[35] As a resident at the time has since testified: "It was then considered that if anything happened to the furnace or mine, Negaunee would be no more. So, when the furnace burned, and its whistle sent out such mournful notes, I felt doleful indeed, for half our town's industry had gone."[36] The furnace was rebuilt in 1877.

Like the earlier forges, the furnaces caused rapid depletion of the hardwoods near them. In 1869, the Pioneer furnace used the timber from at least 1500 acres of land in producing 9500 tons of iron.[37] Where the furnaces were in a mining town, as was true of the Pioneer, the removal of the forest growth facilitated the discovery of ore,[38] and enabled the town to expand its gardens and grazing lands. Where the furnaces were located some distance from a town, as the Morgan furnace about five miles east of Negaunee, the clearing had no effect on agricultural settlement but simply converted virgin forest into cut-over.

Other Industries. The Pioneer furnace was not the only Negaunee industry dependent on the forest resources of the surrounding area. There were two small saw mills within the city (1870), both operated by mining companies. A larger one was

[35] Sawyer, Alvah, *A History of the Northern Peninsula of Michigan*, (1911) I, 427.

[36] Maitland, Carrie V., "Negaunee" (Manuscript, 1918, Marquette County Historical Society).

[37] The acreage was estimated on data from Swineford, *The Lake Superior Iron District* (1869), 29; and Mather, "Charcoal Iron Industry for the Upper Peninsula of Michigan," *L. S. M. I.* Proc., IX (1903), 66-67.

[38] "This business did much to stimulate the settlement of the district by clearing away the forests, whereby many finds of ore were made . . ." Jopling, "The Marquette Iron Range," *Trans, Am. Inst. Min. Eng.* (1897).

located at Eagle Mills, three miles east of Negaunee but near enough to draw on the Negaunee stores for food and clothing.

Agriculture deserves mention in a negative way only, for it was practically non-existent except in the immediate environs of the city.[39] In 1860, the "iron township" of 83.6 square miles, which included both Negaunee and Ishpeming, contained only three farms.[40] In 1864, 122 tons of hay and 2445 bushels of potatoes were produced in the township, but no wheat or other grain.[41] The area was reported to contain only 15 milk cows, 2 sheep, and 13 swine. These data clearly indicate the absence of agricultural products and a rural market on which urban commercial life might have depended.

Development of the Commercial-Residential Nucleus.—The notable expansion of iron mining and manufacturing which characterized this period resulted as previously stated in the development of the original mining camp into a small city. The settlement grew by the erection of houses east of the mine along the plank road

[39] The early reports of the agricultural resources of the Lake Superior Highland around Negaunee were not such as to attract farmers.

(a) After viewing the hills north of Negaunee from peaks near the Lake Superior shore, McKenney wrote that the mountains were "all barren, and thinly clad with stunted growths of pine, cedar, hemlock, and which is not sufficient to hide their nakedness." McKenney, Thomas L., *Sketches of a Tour to the Lakes* (1827), 233.

(b) Douglass Houghton tempered this harsh description a little by saying, "The section . . . though broken by knobby and often sterile hills is very far from being wholly or even generally sterile . . ." Fuller, George Ed., *Geological Reports of Douglass Houghton,* 1837-1845. (Lansing, 1928), 562.

(c) Burt's field notes are full of references to rock outcrops and rock hills and swamps, and his sketch map of the environs of Negaunee indicates that the area is a part of the "Iron Mountains" and shows much of the land as hilly or swampy. Burt, *United States Gov't Field Notes,* T. 47 N., R. 26 W. 1844-1845. The general description prepared by Burt's associate, Samuel T. Hill, stresses the same features. *General Description of Township 47 N. Range 26 W. 1844* (Photostat of Manuscript, Marquette County Historical Society).

(d) Foster, writing of the area just south of Negaunee, said: "The desolate and forbidding character of the regions, consisting mainly of low tangled swamps, and barren ridges, can hardly be imagined." Foster and Whitney, "Report on the Geology and Topography of the Lake Superior Land District," *Sen. Doc. No. III, Spec. Sess. 32nd Cong. (1851) Vol. 4, Part II,* 44.

[40] *Statistics of Michigan, Compiled from the Census of 1860,* (Lansing, 1861), 181-87.

[41] *Census and Statistics of Michigan, 1864* (Lansing, 1865) 354ff.

and its successor, the railroad. The first regular plat was not located, however, until 1865.

In that year,[42] the Iron plat was laid out across the Partridge Creek valley at the east end of Jackson Hill, half a mile east of the original settlement (Fig. 10). It included the junction of the two railroads, and the depots and stores that had grown up there. Western Iron Street (Fig. 2) was located to coincide with the plank road, but instead of turning northward with the road, it continued due east. The other streets were laid off parallel or perpendicular to it. Although a strategic location for commerce, the site was otherwise a poor one, for the valley was swampy and even flooded after heavy rains. The poorly drained character of the land and the presence of railroads, stores, and saloons, made this an unsatisfactory area for residences.

Far better for residential purposes was the Pioneer plat laid out three years later by the Pioneer Mining Company on the flattish plain north and east of Partridge Creek (Fig. 10). This plain had early attracted attention because it was covered by the "best hardwoods in the region." After the timber had been cut to supply the Jackson forge and the Pioneer furnace with charcoal, the eastern part of the plain was divided into strips and sold without mineral reservation to some of the French-Canadian wood choppers employed in cutting wood for the furnace. They wished to farm on a small scale, and the plain, in addition to being well-drained and smooth, had a deep, sandy-gravelly soil, which proved to be quite fertile in its virgin state. These same qualities made the land suitable for residential use (for gardens as well as houses), so when the need arose the western part of the plain was divided into city lots. Despite the opinion then held that the entire plain was barren ground, the company, while selling the surface rights to the platted portion, retained the mineral rights.

The peculiar orientation of the street grill adopted for the new plat was due to the location of Main Street to coincide throughout its extent with the plank road, which ran east-northeast from the center of Iron Street toward Marquette, and along which residences had already been established. Most of the other streets were located parallel or perpendicular to Main Street. A road which followed a small ravine toward Teal Lake limited the plat on the northeast; on the north, the streets stopped at the edge of the

[42] Plat Books, Office Register of Deeds for Marquette County, Marquette, Mich.

plain where Teal Lake Hill begins; on the west, Tobin Street was laid out north and south along the section line (Sec. 1 and 6), instead of conforming to the general pattern of the streets; the southern and south-eastern boundaries of the plat were determined by the earlier location of the Iron plat and the Marquette, Houghton, and Ontonogan Railroad.

The city thus became fixed with these two plats as the urban nucleus instead of the original settlement at the Jackson mine, and—except for the swampy character of much of the Iron plat—the site must have seemed ideal at the time. It lay at the convergence of valley routes and the roads and railroads which followed them. It was just to the east and north of what was supposed to be the

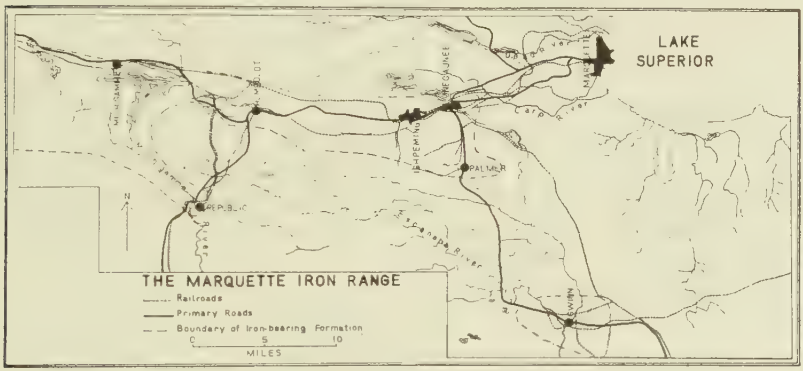

FIG. 9.

boundary of the mineralized area, and so was released by the mining companies for other uses; yet it was near enough to the mines to accommodate the miners. There was an abundance of smooth, well-drained land for dwellings and gardens, and even pasture for cows. On the other hand, the mining companies refused to sell the land west and south of the two plats, on the north was an inhospitable ridge, and the land to the east was too far from the mines and the junction of the railroads.

The Open-Pit Cycle: Maturity (1870-85)

The Growth of Negaunee.—The period of rapid growth inaugurated by the construction of the Soo Canal and the railroad from Negaunee to Marquette came to a close about 1870, and for the next fifteen years Negaunee grew but little. The graph in

Figure 11 shows a relatively slight increase in population, and, except for two small additions in 1882, there was no expansion of the platted portion of the city. The failure to maintain the rate of growth of the immediately preceding years was due primarily to changes in the condition of the mining industry.

Climax of the Open-Pit Cycle.—The period of vigorous expansion of open-pit mining ended about 1870 as the production of ore settled down to a state of equilibrium in which the output from new mines did little more than offset the decline in production at the older ones (Fig. 11). The Jackson mine, although it continued for some time to furnish most of the ore shipped from Negaunee,[43] had reached a point in its development at which the easily exploited surface deposits of high-grade ore had been exhausted. With the necessity of sending the pits ever deeper in search of ore the production actually suffered a slight decline. On the other hand, the new mines which were opened to exploit the small scattered outcrops of soft ore were so unimportant that their combined output was barely sufficient to counterbalance the decrease in production at the Jackson. As subsequent events proved, this static condition of the mining industry marked the climax in the utilization of the surface deposits of ore—the mature stage in the open pit cycle.

Minor Industries.—The slight growth of Negaunee between 1870 and 1885 was due not only to the failure of the mining industry to expand, but also to the fact that no significant growth took place in other industries. Those which had been established previously experienced no noticeable development, and the new ones were either unsuccessful or too small to contribute notably to the growth of the city.

The fabrication of local raw materials for distant markets continued from the preceding period with little change. The

[43] The importance of the Jackson Mine is shown in the following statement, which gives the percentage of the total ore shipments sent out by the Jackson Mine (b), and the total number of shipping mines (c) for the years 1871-85 (a):

(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
1871	97	3	1876	51	7	1881	52	9
1872	87	3	1877	49	6	1882	40	8
1873	87	3	1878	51	6	1883	48	11
1874	84	3	1879	38	9	1884	46	7
1875	70	3	1880	56	10	1885	41	6

Compiled from *Mineral Resources of Michigan*, 1912.

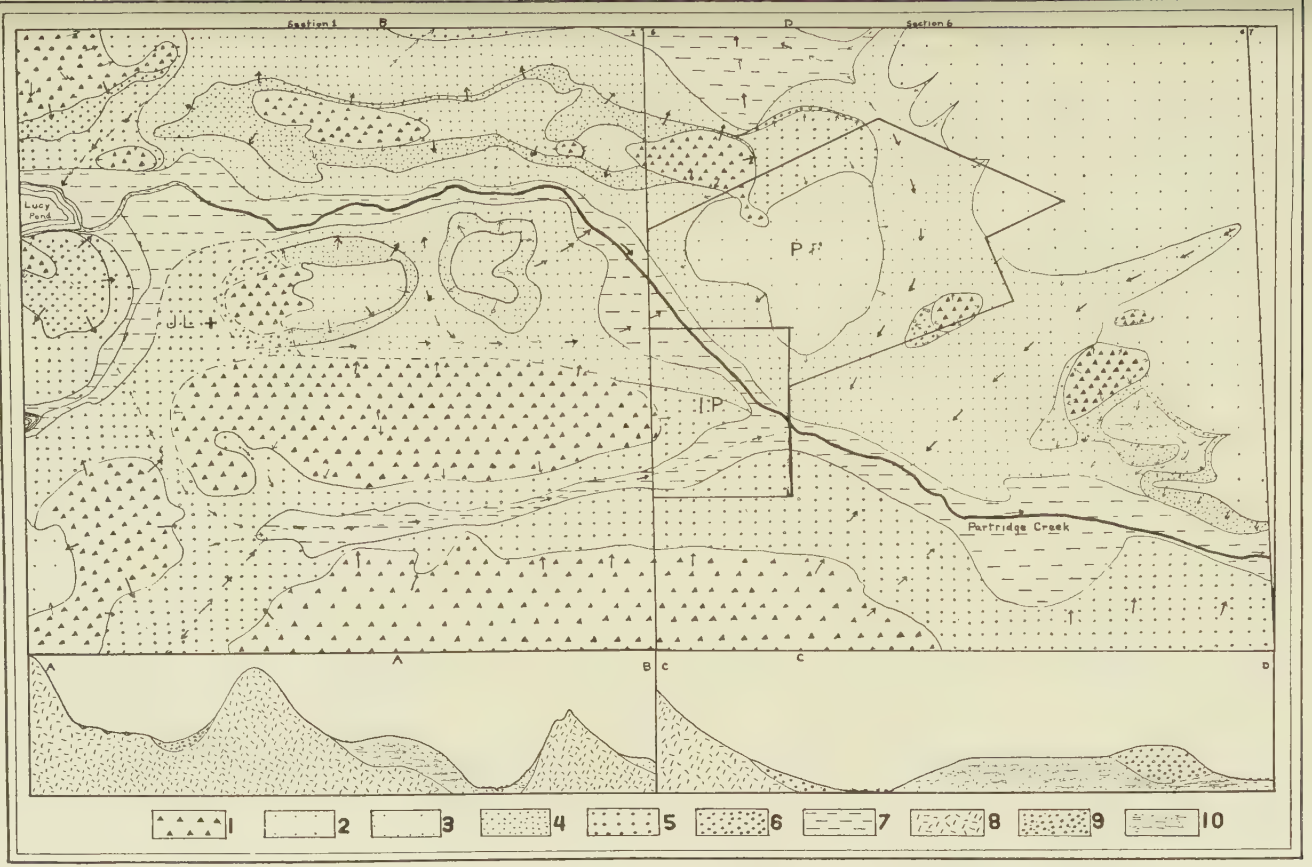

FIG. 10.—The Site of Negaunee: Land Forms. 1—Ice-scoured knobs; 2—outwash flats of sand and gravel (well drained); 3—moderately sloping outwash (2°-10° slope); 4—steeply sloping outwash (10° or more); 5—moderately sloping moraine; 6—steeply sloping moraine; 7—valley botton flats (poorly drained); 8—crystalline rock; 9—till; 10—outwash; J. L.—Jackson Location; P.—Pioneer Plat; I. P.—Iron Plat. (Vertical scale of cross-sections is five times the horizontal.)

Pioneer furnace was operating as before. The lumber industry was represented by a saw mill of moderate size at the southeast corner of Teal Lake.[44]

Two new industries, a concentration plant and a candle factory, reflected the status of the open pit mines. As the rich surface deposits at the Jackson mine were depleted, an attempt to "beneficiate" the low-grade ore was made.[45] A concentration plant was erected (1880) on a small rock knob on the north side of Partridge Creek opposite the mine, where one can still see the foundation stones and piles of crushed rock. It was expected that crushers would pulverize the rock so that the hematite could be separated from the jasper. The plant failed in the face of insuperable difficulties, chief of which were the excessive wear of the jaws of the crushers and the lack of an effective device for separating the particles of iron oxide from the silica after the rock was crushed. The experiment indicated a scarcity of easily worked ore bodies, and its failure closed one avenue of escape from the necessity of excavating the pits to greater and greater depths in order to reach ore. The increasing depths and underground extensions of the open pits, and preliminary experiments in shaft mining created a need for artificial light in the mines. The candle factory, located on Jackson Hill above the most eastern of the pits, doubtless supplied this market in addition to meeting domestic needs.

Two other factories dependent on the local market were a brewery and a carriage and wagon plant. The brewery was located in the southern part of the Iron plat in a stone building now occupied by a flour mill. A block east of it was the carriage and wagon factory, now a gray ruin of crumbling buildings. These two plants complete the list of industries on which Negaunee depended for a livelihood.

The Cultural Landscape.—As a result of two decades of prosperity, Negaunee had taken on the appearance of a permanent city. The bird's eye view in Figure 12[46] shows that the framework

[44] Sandborn's Maps of Negaunee for Insurance Companies (New York, 1884), Detailed Sheets.

[45] Lawton, Charles D., *Mineral Resources, State of Michigan, 1886* (Lansing), 30; Sanborn's Maps of Negaunee (1884), Detailed Sheets.

[46] The description is based on this view (published by J. J. Stoner, Madison, Wis., 1881) and two other sources—Spalding, E. M., Map of Negaunee in 1876 (Phoenix Map Co., Milwaukee); Sanborn's Maps of Negaunee for Insurance Companies (N. Y., 1884).

provided by the two original plats had been filled in with substantial two and three-story buildings except where railroads and mines interfered. There were at least three churches, a large high school building, and several hotels. The business street was closely lined with brick and wooden structures.

The view in Figure 12 shows most of the industries on which the city depended; the mines along the north slope of Lucy Hill, the Pioneer furnace and the battery of kilns, the brewery, and the carriage factory. However, only a small part of the Jackson mine can be seen (at the west end of Iron Street) and the view is too restricted to include the mines southeast of the furnace and along

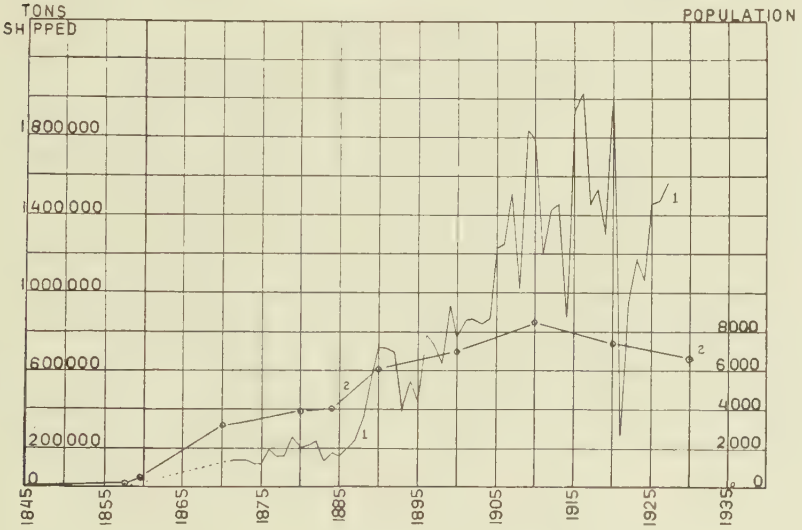

Fig. 11.—Population and Ore Shipments.

the south side of Teal Lake, as well as the lumber mill on the southeast shore of the lake.

By 1881, the utilization of the Iron and Pioneer plats had become definitely specialized in harmony with the natural advantages which each possessed. Iron Plat had become the commercial and industrial area. The commercial district remained where it had started along Iron Street, whereas the central and southern part of the plat, instead of being divided into building lots and blocks as originally planned, was occupied by railroad lines, factories, and one mine. Pioneer Plat was devoted almost entirely to residential and institutional use (Fig. 12). A secondary residential district had

developed west of the swampy Partridge Creek valley on the Jackson mine property (Section 1). The street pattern of this district was laid out on an extension of Iron Street as a base, but shows some evidence of a tendency to conform to the irregular topography.

It is worth noting, too, that the extensions and outlying "islands" of residential land characteristic of Negaunee today had already begun to form. At the extreme west end of Iron Street was an isolated group of houses, some if not all of which were typical "company houses" erected by the mining company for its employees. Along the roads which led to the other mines were similar clusters.

Close of the Period.—After 1879, the failure of exploration to reveal any sizeable surface ore bodies and the unfortunate outcome of the experiment at beneficiation focused the attention of the mine operators on the "underground" deposits. When the pits got so deep that the removal of the overburden became unprofitable, inclines were put down and stopes were opened, supported by pillars of ore or timbers. Small shafts were also driven to open up ore bodies which test pits and diamond drill holes had disclosed. Experimentation in underground mining was under way.

Although shaft mining had begun by 1880, there were no important shipments from shaft mines until 1886. The intervening years present the period of initial development—the infancy—of the shaft-mine cycle. Meanwhile, open pits continued to furnish employment for most if not quite all of the miners of Negaunee. Because of this overlap of the open-pit and shaft-mine cycles, several shaft mines were producing actively before the last of the open pits were abandoned. Negaunee was thus spared the serious depression which doubtless would have occurred had experimentation in underground mining been delayed until open pit mining had ceased.

With the inauguration of shaft mining the cultural landscape underwent a marked transformation.

The Shaft-Mine Cycle: Youth (1885-1910)

Growth of Negaunee.—Negaunee entered a second period of rapid growth about 1885 (Fig. 11). By 1910, the population had more than doubled, and the platted portion of the city had been extended until it was 2.6 times as large as at the beginning of the period. Because of numerous changes in the landscape during this period and the lack of notable changes since, the appearance of the

city in 1910 was much the same as that of today (Figures 1, 2) in the character and general arrangement of the roads, mines, and other features which make up the cultural pattern. The growth and expansion of the city were stimulated to some extent by the climactic development of forest industries in the region around Negaunee, but in far greater measure by rapid exploitation of deep-seated bodies of iron ore.

Readjustments in the Mining Industry.—The mining of these hidden resources, which resulted in an increase in ore shipments from 165,174 tons in 1885 to 1,796,265 tons in 1910, was associated with a number of readjustments in the industry. The methods of

FIG. 12.—Negaunee in 1881.

mining and exploration, the character of the mining companies, and the kinds of tasks required of the mine employees all underwent noteworthy changes.

The methods employed in mining were decidedly experimental at first, but before the period was half over, satisfactory adjustments to underground conditions had been worked out.[47] The task was least formidable at the Jackson mine, for there deep pits served in place of shafts, and the strength of the hard ore permitted its use as supporting pillars in *open stope and pillar mining.* Else-

[47] Elliott, S. R.; Jopling, J. E.; Chenneour, R. J.; Derby, E. L., "Mining Methods of Marquette District, Michigan," *Trans. Amer. Inst. Min. Eng.,* 1923; Parks, Roland D., "Recent Developments in Methods of Mining in the Marquette Iron Ranges," *L. S. M. I. Proc.,* XXVI (1928), 115-152.

where, the softness of the ore prevented the use of this method. To meet this problem, the *square set system* was used, only to be displaced later by the more efficient *caving method* of extraction. To reach an ore body not previously exposed by open-pit mining, it was customary, at first, to sink the shaft from directly above, with the result that in most cases the shafts suffered serious injury when removal of a part of the ore caused the overlying rocks to slump or cave. This difficulty was overcome, for the most part, by sinking the shaft in the country rock on the footwall side, from which horizontal tunnels were driven to the ore body. Semi-permanent shafts of this type were being constructed by 1895. Until 1892, when electric haulage was introduced, the underground tramming was done chiefly, if not wholly, by the miners themselves.

Underground mining created a greater need for accurate information about the character of the rock and the distribution of the ore than had existed in connection with open pit work, and at the same time it made notable contributions to such knowledge. The first geological map was constructed on the basis of exposures of bedrock in the pits and on the hillsides. In preparing the map, the geologist refrained from drawing inferences about the formation underlying the drift-covered areas, limiting himself to the ice-scoured areas where outcrops were numerous. The second map was based essentially on the same kind of evidence as that used in making the first one, for it was prepared too soon to benefit much from the information disclosed by the diamond drill (introduced about 1869, but not in general use till 1887) or from that afforded by the new underground workings. Despite inadequate data, the second geologist attempted to show the distribution of the iron formation and the character of the rock between exposures. While doubtless of some value to the mine operators, the map strengthened their conviction, an utterly erroneous one as later events proved, that the Negaunee plain was barren ground. This mistake was corrected when speculative diamond drilling disclosed the ore body from which the Negaunee mine began to ship ore in 1887. In 1897, Van Hise published a map, which, together with his masterly monograph on the Marquette Range,[48] identified the iron-bearing formation and indicated its distribution with a degree of precision that clearly delimited the area within which ore might be found. Furthermore, his theory that the original ore was due to local

[48] Van Hise, Charles Richard and Bagley, Wm., "The Marquette Iron-Bearing District of Michigan," *U. S. G. S. Monograph XXVIII* (1897).

concentration of iron oxide through the leaching action of ground water flowing along structural troughs proved to be highly useful in locating ore bodies. Guided by his work, and aided also by the diamond drill and the accumulating data on rock structures which underground mining afforded, the mining companies were able to locate ore bodies sufficiently large and numerous to permit a marvelous expansion of the industry.

The disclosure in rapid succession of one ore body after another in the southern and eastern part of Negaunee came to a climax near the end of the period with the discovery that the Maas mine, opened in 1906, and the Negaunee mine were working the same deposit, and that it dips gently westward beneath the area occupied by the central residential district. Later discoveries have just about kept pace with the depletion of the developed properties.

In line with the growing complexity and magnitude of the mining operations, there came a greater demand for capital. A small, open-pit mine could begin operations on a few thousand dollars, whereas a shaft mine required the outlay of a million dollars, more or less, before production could begin. As a result, the small companies retired from the field, and were succeeded by the larger and larger ones. Although the consolidation of holdings in the hands of large concerns soon reached the point where four or five companies held control, each with a capitalization many times greater than that required to operate the Jackson mine, most of the companies were not integrated with furnace operators in the Lower Lakes Region. That was to come later.

The change to shaft mining introduced new conditions and new tasks for the mine employees. The surface workers, many of them common laborers, were displaced by skilled "underground men." Carpenters became indispensable in timber framing and fitting, and more machinists, chemists, and engineers were employed. In general, the Cornish miners were the most skillful and willing underground workers, whereas the French Canadian woodsmen flatly refused to work beneath the surface.

It is evident that shaft mining brought about a new relationship between the mines and the forest. Heretofore, the principal connection had been indirect—the forest furnished charcoal for the forges and furnaces which in turn used ore from the mines. In underground operations, however, the relationship became a direct one, for the extraction of the ore and even the security of the miners depended on the use of sound, sturdy timbers. The forest

wealth of the surrounding region was drawn on freely to meet this need. The amount of timber used in the mines and the size of the logs employed—some of them three and four feet in diameter—were the marvel of visitors to Negaunee.

Climax of the Forest Industries.—During the first few years of the period, forest industries were more important in the economic life of Negaunee than ever before or since. The mines used increasingly large quantities of logs, the Pioneer furnace continued to operate with charcoal prepared from hardwoods cut in the vicinity, the Teal Lake saw mill expanded its storage yards, and to the one at Eagle Mills was added a sash, door and shingle factory. The increase in the consumption of logs at the saw mills and in the mines was associated with rapid destruction of the pines in the surrounding area. Although timber cutting had been in progress around Negaunee for many years, and the hardwoods were nearing exhaustion, the pines had been largely untouched (1885). From the tops of the Negaunee hills, one could see "giant pines in every direction."[49] There were "probably twenty other trees to one pine," but the pines were three, four, and even five feet in diameter.

By 1895, the virgin pines were practically all cut. The mills at Teal Lake and Eagle Mills were closed in the early nineties. The buildings were torn down, and nothing but crumbling foundation stones remain to mark the sites. The Pioneer furnace also discontinued operations about the same time, for the decline in the supply of hardwoods for making charcoal and competition with plants located more favorably and operated more efficiently made production no longer profitable. The brick stacks and a few buildings still remain, surrounded by piles of lumber shipped in from distant points of the Upper Peninsula and from other states. The mines, too, found it necessary to draw logs from greater and greater distances.

The passing of the furnace and the local saw mills calls attention to the significance of forest resources in the evolution of Negaunee. A city of six thousand inhabitants and a thousand dwellings (1890), its development had rested at every stage on two resources, the iron ore and the forest, the one as a mineral to be mined and a raw material to be manufactured, the other as a fuel in smelting the ore and as construction material for local and distant markets. Future generations must undertake reforestation of the neighboring lands

[49] Jopling, James E., Personal Communication.

of non-agricultural quality or discover new resources if Negaunee would avoid abject dependence on a single, non-renewable, natural resource.

In contrast to the close of the youthful shaft-mine period, the beginning of it had found the forest industries actively growing, and serving, only less than the expanding mining industry, to attract men to Negaunee.

Expansion of the Residential Areas.—In sympathy with the exceptionally rapid increase in population which began about 1885 (Figure 11), the platted part of the city was notably enlarged. Additions were laid out west, north, and east of the Pioneer plat. Besides the residences which occupied these additions, others were erected near the mines and along the roads leading to them. No small part of the increase in the population was cared for in the relatively numerous hotels and boarding houses.

Completion of the Railroad Net.—During this period of rapid development at Negaunee and the neighboring mining towns, the railroad net which serves the city was brought to completion. Prior to 1881, there were no rail connections with points east of Marquette. In December of that year, a line was opened between Marquette and St. Ignace, at the Straits of Mackinac, and three years later a branch line was constructed to Negaunee and Ishpeming.[60] There were now two lines between Marquette and Negaunee. The railroad net was finally connected with the Keweenaw Peninsula and its copper mines in 1883, and with the Iron River-Crystal Falls iron range a few years later. In 1896, the third and last railroad to be built between Negaunee and Marquette was constructed by the controlling mining interests, and a large steel ore dock was erected at its port terminal. Since that date, abandonments of logging roads and mine spurs have more than off-set the extensions to new mines.

Summary.—The period from 1885 to 1910—the youthful stage of the shaft-mining cycle—was inaugurated by the production of notable quantities of iron ore by shaft mining. It witnessed the perfecting of the new type of mining, the decline of the old type, the opening of the eastern ore bodies, and the final shaping of geological knowledge essential to efficient exploration and mining. During the period, there was an unprecedented increase in ore

[60] Armstrong, "History of Transportation on the Marquette Range" (1929), 12-3.

production, in the population of the city, and in the areal extent of the urban complex. The railroad net was completed—at least so far as the next two decades were concerned—and the industries dependent on forest resources attained their maximum development, after which they declined abruptly. A definite flattening of the curves showing the ore shipments and population of Negaunee (Fig. 11) indicates that about 1910 the community was passing from a period of vigorous expansion to one of comparatively steady, mature exploitation of the deposits of iron ore which the days of youth had disclosed.

The Shaft-Mine Cycle: Maturity (1910-....)

A Mature Mining Settlement.—The concept of *maturity* generally means that the period of rapid growth is over, and that certain evidences of decline have appeared. As applied to a mining settlement, the term implies that the mining industry has reached a state of equilibrium in which the output from recently tapped mineral deposits off-sets approximately the decline in output from the older workings, with no appreciable gain in total production. (It is assumed here that one ignores temporary changes in production due to abnormal market conditions.) If the settlement is *dominated* by mining, its population will be increasing at a diminishing rate, or, if it has passed beyond early maturity, will have reached a "plateau" below which there is a tendency to drop. In addition, one might well expect the community to have become relatively stable, with fewer floating laborers and fewer boarding houses than in the immediately preceding period, with an abundance of dwellings, a fair portion of them privately owned, and with an adequate labor supply from the restricted growth of the town. One should expect, also, that the number of men and women would be similar, a condition seldom if ever found in a *young* mining camp; that there would be a gradual decrease in the percentage of foreign born; and that there would be adequate provision for social needs.[51]

The application of these criteria to Negaunee indicates that it is now (1930) well along the plateau of maturity.[52] (1) The pro-

[51] Most of these criteria were applied—though in a less rigidly quantitative fashion than is attempted here—in characterizing Negaunee for the period from 1870 to 1885.

[52] In calling a mining settlement *mature*, it is well to keep in mind that the characterization is not based on assumptions about the future but rather on facts about the past and present, not on the supposition that old age

duction curve, if smoothed, shows that new developments are just about balancing abandonments, and the population curve shows an appreciable drop from the peak of 1910 (Fig. 11). (2) the population of Negaunee is quite stable, and more than ample for the needs of the mining industry. There are perhaps half the boarding houses and hotels of twenty years ago. Dwellings, most of them privately owned, have continued to increase in number since 1910, despite a marked decrease in the population. Rows of "company houses," monotonously alike, are to be found nowhere except in the Mary Charlotte Location, where there are two rows of five houses each (about 0.7 of one per cent of the total number of houses in Negaunee). Despite a persistent movement of young men away from the city, the labor supply is more than sufficient, with a surplus of about two hundred laborers unable to find regular employment in the mines. (3) At the beginning of the youthful shaft-mining period, the ratio of males to females was 1.19; by its close in 1910, the ratio had gone up to 1.309, but had dropped to 1.03 by 1920. (4) Near the middle of the preceding period, 47.6 per cent of the inhabitants were foreign born, and at its close there were 45.6 per cent; but ten years later the number had dropped to 33 per cent. (5) The social needs of the inhabitants are well cared for with three civic, seven religious, and fifteen fraternal organizations.

The Mature Shaft-Mine Landscape.—As one should expect, the passage from a period of active expansion to one of steady, uneventful exploitation of the previously disclosed resources brought an association of forms somewhat different from those

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and death lie just ahead but rather on the knowledge that the stage of youthful growth is over. Whether old age and extinction will follow maturity will be determined not only by the forces operating at the time, but also by the appearance of new conditions which might bring rejuvenation. Indeed, Negaunee furnishes an illustration of this very principle. The period of rapid growth between 1856 and 1870 was followed by a definite flattening out during the next fifteen years (Fig. 11). When this stage of maturity in the open-pit cycle was interrupted by marked rejuvenation of the settlement through the development of the deeply buried ores, Negaunee entered a new cycle without passing through a period of old age corresponding to that stage in the open pit cycle. Instead, it entered a second period of rapid growth and eventually reach a second plateau of maturity, based on underground mining.

It should be noted, too, that a mining settlement can perhaps escape decline by turning to other occupations—manufacturing, commerce, and so on. In so doing, however, it ceases to be a mining settlement, and becomes dependent on a different set of human and natural environmental factors.

of preceding periods. In the next chapter these landscape forms are discussed in a more detailed and quantitative way than it has seemed desirable or even possible to do for earlier periods. Furthermore, much that might have been given in the preceding pages about the geographical aspects of underground mining has been left for more extended treatment here. Accordingly, while applying particularly to the period since 1910, and even more specifically to the time during which the survey was made, 1927-29, this discussion will not ignore the earlier part of the shaft-mine cycle.

To simplify the task, attention will be focused on the geographical divisions of the city, rather than on the city as a whole. Although this method may seem at first to ignore the functional unity of the city, it is hoped that as the several divisions are described and interpreted, they will be seen as interrelated parts of the larger unit—Negaunee.

III. The Geographical Divisions

The Saxicultural Districts

Distribution.—The mines are among the more prominent landscape features of Negaunee. If one enters the city from the east, attention is drawn at once to the gaunt steel shaft heads and the long piles of red iron ore at their base. The road from the southeast leads by similar shafts and stock piles. The entrance from the west discloses, in addition, numerous open pits now overgrown and partly hidden by trees. Indeed, one or more mines are visible from any point along the main highways which enter the city.

Figure 2 reveals the fact that the saxicultural districts almost encircle the residential and commercial areas. The Jackson, the oldest of the districts, includes two sections, the smaller an abandoned shaft-mine area and the larger an abandoned open-pit area ("8"-"14"). Mining in the youthful open-pit period was confined, almost wholly, to this district. After the soft ores became marketable as a result of changes in blast furnace practice (about 1870), the Lucy and Cambria districts were opened. The Lucy ("9"-"12") is the most extensive of all the saxicultural districts. In going from west to east, one passes through an abandoned open-pit section, which occupies both the northern and southern slopes of Lucy Hill, to the eastern end of the hill, where the district divides, forming two branches each of which has an inactive shaft-mine section and an abandoned shaft-mine section. Associated with the abandoned shaft mines are small abandoned open pits, and there is a small inactive open-pit mine in the southeastern part of the district. The Cambria district ("15"-"4"), like the Lucy, has a section of abandoned open pits and two sections of abandoned shaft mines, but, unlike the Lucy, it has an active shaft mine section instead of two that are inactive.

In contrast to the Lucy and Cambria districts, which began as open-pit areas and served as experimental grounds in the initiation of the shaft-mine cycle, the two districts in eastern Negaunee, the Negaunee-Maas ("1"-"2") and the Athens-Lucky Star ("3"-"18"), began as shaft-mine areas, the former during the youthful shaft-

mine period, the latter after maturity had set in. Both of these districts have an abandoned shaft-mine section and an active one. Open pits are absent, and instead of occupying ice-scoured and morainal slopes, as do the Lucy and Cambria, these two districts are located on the flattish Negaunee outwash plain near its eastern margin.

Types of Mines.—The landscape of the abandoned open-pit sections clearly reflects the mining activity of a by-gone day. The open pits, the most conspicuous features, are located as a rule on ice-scoured slopes. Most of the pits trend east and west in accordance with the trend of the ore bodies. They are remarkably irregular: many small cuts extend from the main pits, and the margins are jagged, precipitous walls blasted from the solid bed rock. The deeper pits are partly filled with water, and the upper slopes of some of the older ones are overgrown with trees several inches in diameter. Scattered around in haphazard fashion are piles of waste rock and low-grade ore. Here and there foundation ruins and road beds indicate where buildings were located. In summer these features are somewhat hidden by the foliage of bushes and trees; in mid-winter, a heavy blanket of snow half fills the pits, softens the angular margins, and contrasts pleasingly with the red and purplish-black rocks; but in autumn and early spring, the pits stand out in stark ugliness against the hill sides.

Where the pits are small and not too numerous and the rock piles are correspondingly small, the land is used for grazing. But where mining has profoundly altered the surface of the land, and where the surrounding area is used in other ways, as in the case of the Jackson district, the open-pit areas are idle. If near residential districts, the pits are well fenced against trespassers, and children are warned to keep away from them. Although the sites of the pits are now useless, it is well to remember that the land originally had little or no value for uses other than mining. The landscape of the one inactive pit is similar to that of the abandoned open-pit type except that the railroad tracks remain in place and a few pieces of machinery lie rusting. This pit represents a recent revival of open-pit mining on the Marquette Range in response to conditions now existing on the Mesabi Range. The alumina content of much of the Mesabi ore is too high to permit the forming of slag of low viscosity and the silica content is too low. To secure the ideal ratio of silica to alumina—three to one—the Mesabi ore is mixed with ores rich in silica. In 1926, the siliceous ore all came

from the Marquette Range, a part of it from the Kruse. The company owning the pit has allowed it to remain idle for the last four years while it mines similar ore in the Palmer district, six miles south of Negaunee. Presumably the Palmer deposit can be mined more cheaply.

The active shaft-mine type is represented by four mines, the Cambria-Hartford, the Athens, the Maas, and the Negaunee. The more conspicuous features at each mine are the steel shaft head, 110 feet high, and the stocking trestle and stock pile, 35 to 48 feet in height. Each mine has, in addition, a timber yard of 2 to 4 acres and a number of buildings such as the machine and carpenter shops, the change house or "dry" where miners change to their work garb before entering the mine, office buildings, warehouses, laboratories, and a heating plant. Electric power lines lead to three of the mines, one of which has a carbo-electric plant for use in emergency. The fourth mine has a carbo-electric plant which is kept in constant operation. Besides these elements, the active shaft mine landscape includes the launder, which is a surface drain to lead away the ground water pumped from the mine, several railroad tracks, and one or more "cave-ins."

The cave-in is a break or slump in the surface of the ground above a place from which the ore has been removed. No matter if the ore body be hundreds of feet below the surface and overlain by several hundred feet of bedrock, the removal of the ore will ultimately cause a cave-in unless the cavity made by mining is filled with waste rock or sand, a corrective measure that has never been undertaken in Negaunee. The cave-in usually starts as a funnel-shaped depression similar to a sink hole in karst topography. Two or more of these sinks may join to form a long trough. Needless to say, caved land is not only useless but is even dangerous to live stock and children. Accordingly, cave-ins are always kept well fenced against wandering cows and are avoided by both children and adults.

Not only in the vicinity of the cave-ins but also over the whole shaft-mine landscape, there appears remarkably little human activity. In winter, when the steam shovels are idle and the work of shaping timbers is being done under shelter, there is likely to be no one in sight most of the time. The monotonous hum and whir of machinery is varied a little when the small ore cars appear at the junction of the shaft and trestle, run out on the latter, drop their load of ore, and return. Only when the men, perhaps 750 of

them, are entering or leaving the mines does one get an accurate notion of the activity going on below the surface.

The landscape of the inactive shaft-mine type reflects the dormant condition of the mines. The buildings are boarded up, and the stock piles are low or absent. The aspect of desertion is relieved in summer, for then one sees a large number of cows grazing around the buildings, walking over the railroad tracks, and moving about the shaft heads; but it is intensified in winter when the buildings stand half buried in snow, no roadways are plowed through the drifts from the main highways, and the cheery, irregular tinkle of cow bells may not be heard.

The three inactive shaft mines are idle for different reasons. The ore tapped by the Breitung, opened in 1914 and shut down in 1919, is being held as a reserve supply, somewhat too rich in sulphur for the present market. The property changed hands in 1921, and the new owners re-timbered the drifts and allowed the mine to fill with water. All the machinery remains in the mine. During the summer of 1928, the mine was pumped partly dry and the shaft repaired, but there is no expectation that it will be opened in the near future. The Rolling Mill was closed in 1927 because the salable ore had been exhausted. This was the oldest producing mine in Negaunee, dating its first shipments from 1871. It is now "practically worked out," and is not likely to be reopened unless and until marked changes take place in the demand for low grade ore. The Mary Charlotte closed down in November, 1928, after three months operation prior to which the mine had been idle for half a year. The reason given for closing the mine was the lack of a market for twelve months' production: it was found that the profits were being consumed in keeping the pumps going and in making requisite repairs during the idle months. The shaft was repaired, and the mine allowed to fill with water. It will not be opened again until the market is better. As near as can be determined, the mine suffers from two handicaps: it appears to be a marginal producer, and its owners lack furnace connections which would tend to guarantee a steady market for the ore.

The abandoned shaft-mine type is seen in the picture in Figure 7. Complete abandonment is the theme here, just as in the abandoned open-pit areas—foundation ruins, rock piles, pieces of broken machinery, idle roadways, and cave-ins partly filled with water. In the Queen section some of the buildings are still standing, but in the Cambria district they have all been destroyed.

These abandoned shaft mines date from the early part of the shaft-mine cycle. In or near each section, mining began first in open pits. But the surface deposits were small, and the initiation of shaft mining within less than a decade made available a method of tapping the more deeply seated ores. By 1917, the last of these mines was abandoned.

The Active Shaft-Mine Sections.—In this interpretation of the active shaft-mine complex, several major topics will receive attention: (1) the location of the mines, (2) the layout of sub-surface workings, (3) the timber needs and supply, (4) the power needs and supply, (5) labor conditions in the mines, (6) capitalization of the mines, and (7) market conditions.

(1) The location of the active shaft mines is related to the natural environment in several ways, the obvious connection being the relation to the distribution of the ore bodies. The formation which contains the ore lies interbedded with slates and quartzites, the entire series forming a narrow east-west synclinorium extending from Negaunee westward beyond Michigamme.[53] North and south of this canoe-shaped series of metamorphic rocks lie barren granites and greenstone schists. Accordingly, the mines, including those at Negaunee, are concentrated within an east-west zone about thirty miles long and two to six miles wide (Fig. 9). Within this zone, ore bodies occur only where structural conditions have permitted the enrichment of the iron formation. The synclinorium has been intensively faulted, folded, and cut by intrusive dikes and sheets, with the result that there are numerous structural troughs, along which the flow of ground water has enriched the iron formation, thereby forming irregularly distributed masses of ore. In the Negaunee area, however, the occurrence of the ore bodies in minor folds at the bottom of the synclinorium has given rise to a rough north-south arrangement of the mines.

The location of the mines is related, also, to the distribution of the ice-scoured knobs with their outcrops of iron ore. As previously explained, the knobs became the sites of the first mines

[53] Recent publications describing the distribution of the ore and the structure of the iron formation are: Royce, Stephen, "Certain Advances in Geological Information Relative to the Lake Superior Iron Deposits," *L. S. M. I.* Proc., 24 (1925); Archibald, Ralph S., "Exploration of Iron Ore in the Lake Superior District," *L. S. M. I. Proc.*, 24, (1925), 280-92; Derby, E. L., "Geology of Ores on the Marquette Range," Reprint from *The Mining Congress Journal,* Oct., 1929.

because there ore was discovered first and could be mined easily. The first shaft mines were opened to tap these ore bodies at a depth to which the pits could not go. The members of this first series of shaft mines are now abandoned or idle. Presently, the use of the diamond drill enabled the explorer to investigate adjacent properties for extensions of ore from the proved areas. The success of these efforts resulted in the opening of the "old" Negaunee, the Cambria-Hartford, and the Athens.[54] The Maas and the present Negaunee workings belong to a third series of shaft mines, for they represent extensions from the old Negaunee mine. The Maas, Athens, Negaunee, and Cambria-Hartford are active mines because they depend on ore that lies near the ice-scoured outcrops, and that, nevertheless, is sufficiently distant and deep seated to have escaped earlier attention; whereas, mines which exploited ore that was more intimately related to the outcrops are abandoned or idle, and areas overlying more remote ore bodies have not been occupied by mines at all.

The location of active mines is related, also, to the depth at which the ore occurs. The older mines, now idle or abandoned, tapped the shallow deposits. The deeper ores were left until improvements in mining made it feasible to work them. In the Athens, the deepest of the active mines, work is being carried on 2400 feet below the surface. Ore at greater depths remains untouched. There are no mines in the Partridge Valley, just north of the Jackson pits, despite the fact that a rich deposit—probably a continuation of the Maas-Negaunee ore body—lies about 3000 feet below the surface, and the only unexplored trough in Eastern Negaunee is one in which ore is likely to be found at comparable depths.

The site of the surface part of each mine is determined by the location of the shaft. Formerly, the shaft was driven directly down to the ore body, but the present practice is to place it in the solid footwall, far enough from the ore so that it will not be disturbed by caving. The fact that the two shafts at the Negaunee

[54] The following references describe the development of the four active mines and the old Negaunee mine: Jopling, James E., "Negaunee Iron Mines," *Negaunee Iron Herald*, Nov. 10, 1923; Elliott, S. R., "The History and Organization of the Cleveland-Cliffs Iron Company," Reprint from *The Mining Congress Journal*, Oct., 1929; Newett, Geo. A., "The Marquette Iron Range of Michigan," *L. S. M. I. Proc.*, 14 (1909), 19-26; Newett, Geo. A., "The Marquette Iron Ore Range," *L. S. M. I. Proc.*, 24, 1925), 209-34.

mine ("1," Fig. 2) were likely to become unsafe because they passed through the ore led to the sinking of a new one in 1910. The company also wanted a location that would give the minimum rock drifting to reach the ore, and the minimum haulage to the shaft, consistent with the need for protection from caving. Sufficient room for a stock pile was also necessary. A site that met these several requirements was found near the edge of the outwash plain, and a test pit was put down through 68 feet of "sand and hardpan" to the bed rock. A concrete shaft was sunk, for which gravel from a nearby pit was used. The Athens and Maas shafts were likewise sunk some distance from the ore body. The Maas ("2," Fig. 2) encountered "quicksand" through which it had to go 167 feet to bed rock. Started in 1902 and not finished until 1906, it proved to be one of the more difficult and expensive shafts on the Range. Though a matter of considerable importance in the process of sinking the shafts, the character of the glacial drift has not been a factor in determining their location.

(2) The sub-surface layout of each mine is controlled primarily by the method of extraction adopted. In three of the mines, the top-slicing method is used exclusively, and in the fourth it is employed to some extent. This method is held to be more efficient than any other in mining ore bodies of the shape found in the Athens, Negaunee, and Maas mines. The evolution of top-slicing methods from earlier practices is best illustrated in the history of the Negaunee mine.

In earlier years, the Negaunee was mined by the use of open stopes and square sets. The stopes were limited to the upper levels, where the rock pressure was slight. In general, too, the ore was too soft to make this a practicable method. The square set system was the predominant one both here and in the other mines of the city. In mining the ore, a platform was erected on four posts which were seven feet high and were set at the four corners of an area seven feet square. Working on this platform, miners removed ore from one side, and from overhead. As the work advanced in height, a second set of legs was placed on the first, then a third, and a fourth, until the framework was forty to fifty feet and in extreme cases even a hundred feet high. When no more ore could be removed from this series of square sets, a second was begun at the base of the first. The defects of the system were pronounced. It used large quantities of the best timber for the vertical posts or legs. It was wasteful of ore. It was also

dangerous. The many-storied scaffolding occasionally collapsed, causing frightful loss of life. Despite the loss of ore and life which the method entailed, it seems to have been displaced by the top-slicing method, introduced by miners from northern England, primarily because the latter required less timber, and permitted the use of timber of an inferior grade.[66]

The underground plan of the Negaunee mine typifies the relationships that exist between the top-slicing method and the subsurface environment of the active mines of the city. The main tunnels, one hundred feet apart vertically, run from the shaft through the country rock to the ore. Cross-cuts, 150 feet apart, extend from each main level through the ore body. On each cross-cut, two-compartment "raises," really miniature shafts, are driven almost vertically upward to the top of the ore body or to the cross-cut above. The ore around each raise is mined by driving six short tunnels or "slices," three on each side. The slices are perpendicular to the sublevel except near the edge of the ore body, where they radiate to get all of the ore. The ore is moved by electric scrapers from the face of the slice to the mouth of the raise, where it falls down the chute to the cross-cut below. Mining ceases in each slice when the face has been pushed back 75 feet from the raise. After a mat of poles has been laid down, the drift is abandoned, and the overburden is allowed to crush down on to the mat while a second slice is begun next to the first one. When the ore on one level is mined out, a second level is begun eleven feet below the first. Here the slices are taken beneath the mat of poles laid down on the floor of the level above. As the top of each slice is only a few inches below the bottom of the one above, no appreciable amount of ore is left between the roof of the one and the floor of the other. In this way, the miner works at the top of the remaining portion of the ore body and beneath a protecting mat of timber above which the ore has been removed.

The top-slicing method is a highly satisfactory one to use in mining the great, broad bodies of soft ore found in these mines. (a) It requires perhaps a third as much timber as did the old square sets. (b) Its use permits the reopening of a mine after a period of depression, with practically no loss of ore due to caving during the idle period, and with relatively quick recovery

[66] Elliott, Jopling, Chenneour, and Derby, "Mining Methods of Marquette District, Michigan," *Trans. Am. Inst. Min. Eng.* (1923).

to normal production. (c) It is less hazardous than most other methods. The miners work at all times under a protecting mat of timber, and, since the overburden is blasted down onto the mat if it does not settle of its own accord, there is little danger from sudden caving. There are never any large stopes which might collapse, and unlike the square set system, there are no scaffold-like structures of timber to fall. (d) It gives a better grade of ore than do other methods. The country rock does not become mixed with the ore; this makes it possible to mine leaner ores without danger of dropping below the iron content set by current market demand. (e) It permits the recovery of nearly all of the ore. Even the small off-shoots can be reached by slices radiated from the raises. Parks writes, "Top slicing has as its primary object the mining of every pound of ore. Under normal conditions, the extraction by this method closely approaches its goal of 100 per cent and exceeds the average sub-slicing extraction [the other method most commonly used for this type of ore body] by a margin of probably 20 per cent." [56]

At the Cambria-Hartford, the conditions are sufficiently different from those found at the other mines to require the use of a different method. The ore is harder, the ore body is more nearly vertical, and the hanging wall is firmer than in the other mines. The top-slicing method failed there because the ore broke out in masses too large to permit the use of standard-sized drift sets. The problem was solved by driving tunnels two sets high through the ore body and then mining the ore by stoping, the hardness of the ore and the strength of the hanging wall permitting the use of this method. This mine produced only 11 per cent of the total for Negaunee in 1927.

(3) Iron mining in Negaunee, though less extravagant in the use of timber than formerly, still requires large quantities of it. In 1927, the Negaunee mine consumed .72 cubic feet of timber per ton of ore mined, and the Mary Charlotte .95 cubic feet.[57] The

[56] Parks, Roland D., "Recent Developments in Methods of Mining in the Marquette Iron Ranges," *L. M. S. I. Proc.*, 26 (1928), 146.

[57] a. The average quantity of timber used per ton of mineral mined in the United States is .33 cubic feet for bituminous coal, .70 for anthracite, .90 for iron ore, and .75 for other ores. Zon, Raphael, "Forestry and Mining in the Lake Superior Region," *L. S. M. I. Proc.*, 24 (1925), 271.

b. For a "typical" top-slicing mine, the cost of timber was $0.27 per ton in 1927. Parks, Roland, "Recent Developments in Methods of Mining in the Marquette Iron Ranges," *L. S. M. I. Proc.*, 26 (1928), 148.

inability to use wood substitutes to any appreciable extent in underground work makes wood indispensable. Steel is the most common substitute, but it is rigid and not easily shaped. Wood is light, strong, and readily framed,—"and by its fibrous structure is a yieldable material. It is due to this last property that wood has maintained its vital position in the mining industry, whereas it has been replaced by stronger materials in most other constructive work."[88] Mine supports must hold up the overlying rock mass, but, since the movement of the overburden cannot be stopped, the supports must yield with the load and at the same time retain their powers of resistance. No material meets this requirement quite so well as wood. To supply the mines with timber, logs are shipped by rail from distant points, for although Negaunee occupies a forest clearing, the forest is inferior second growth and furnishes no wood suitable for this purpose.

The timber supply problem is aggravated by the necessity for early replacement, for "in the majority of cases, probably 99 per cent, the life of any wood in underground usage is a mere fraction of its life in structures on the surface. . . . Air is limited in quantity and often liable to be stagnant and to contain low oxygen content. What air is available is seldom of the proper moisture content. It is either too dry or too damp. Light is practically nil, especially sunlight. . . . The timber is subjected to pressure of a continuous and unusual cumulative nature. Each of these circumstances tends to shorten the life of the timber. . . ."[89]

To prolong the life of the timber, preservatives are used with considerable success, and attention is given to placing different kinds of wood where they will give the best service. All timbers intended for use in the main haulage drifts of the Maas, Negaunee, and Athens mines are first treated with a 5 per cent zinc chloride solution. A plant for this purpose was erected at the Athens mine (1923) in an attempt to check the deterioration of timbers on the main levels. Actual tests in the Athens have demonstrated that the life of the treated timber is four to six years, as compared with one to two years for untreated timber. Unfortunately, experiments show that it does not pay to treat sublevel and slice timber, or that used in wet places on the main levels. Much can be gained, how-

[88] Parks, Roland, "Timbering Practice in the Michigan Iron Mines," *L. S. M. I. Proc.*, 26 (1928), 168-9.

[89] *Ibid*, 154.

ever, by carefully selecting the kind of wood to be used in such places. In general, hardwoods should be used where the workings are damp, and soft wood where they are dry. The life of birch timber is two to three times longer in a wet spot than in a dry one, while hemlock rots quickly in wet places, but tamarack—an exception among soft woods—is much longer lived where the earth is wet.

(4) No less imperative than the need for timber in the active shaft mines is the need for power—for lighting, hauling, and hoisting, and for operating the air compressors, the pumps, the scrapers, and other machinery. The compressors in the mines on the Marquette Range must force 300 cubic feet of air per minute into the underground workings for each laborer there. The use of power for pumping varies more widely. One thousand gallons of water are pumped each minute from the Maas, and only 225 gallons from the Athens, although when first opened the quantity at the Athens was much greater than now. In the Negaunee mine, 1150 gallons per minute are pumped a vertical distance of 900 feet or more to the surface—an average of 920 gallons for each ton of ore mined. Since 1922, electric scrapers have entirely displaced the hand shovel in loading ore. Numerous other mechanical devices have steadily increased the consumption of power.

The power supply is related to conditions of situation, rather than of site. The Cambria-Hartford depends on its own carbo-electric plant, which uses coal from Pennsylvania. Like the other Lake Superior mines which use coal, it benefits from the cheap rates granted by the ore boat operators for the return trip to the Upper Lakes. It also has the advantage of a short rail haul, being only thirteen miles from the port of Marquette. The Athens, Maas, and Negaunee mines depend on hydro-electric power generated in the surrounding glaciated region.

The natural environment of the Marquette Range and adjacent areas has made for relatively large water power resources, even though the rivers are small. Glacial waterfalls are numerous, particularly in the Carp and Dead Rivers, which drop 800 feet from the Lake Superior Highland to the lake in about 12 miles. Lakes and swamps furnish natural reservoirs, and most of the falls occur where narrows—cut in the crystalline bed rock—afford satisfactory dam sites for reservoirs. The rainfall is moderate, varying between 21 and 38 inches per year at the mouth of the

Carp, and between 24 and 48 inches at the Hoist dam on Dead River. The more serious defects are the long period of snow in winter, and the usual mid-summer drought, but the large natural and artificial reservoir capacity overcomes, for the most part, these deficiencies in the run-off. The magnitude of the falls tends to compensate, too, for the small size of the streams.

The cultural development of the Marquette Range has greatly favored the utilization of the available water power resources. (a) The zone of towns and cities extending from Negaunee west to Michigamme (Fig. 9) furnishes a fairly compact market for electricity for lighting purposes, and the mines, near which these urban centers have developed, need electricity for both lighting and power. (b) A large part of this market consists of the demand for power and light in the mines, shops, and offices of one large company, the Cleveland-Cliffs Iron Company. An organization of great financial strength, the Cleveland-Cliffs was able to make the heavy initial investments demanded in hydro-electric development. (c) Keen competition with the open pit mines of Minnesota forced economies in the underground mines if they were to survive. One step in the effort of the Cleveland-Cliffs Iron Company "to reduce the cost of the ton of ore at the mines" was the utilization of the nearby water power resources in place of Pennsylvania coal, "and the step was a great one."[80] (d) The presence along the stream courses of cut-over and second growth woodland, instead of agricultural lands, made it possible to create large reservoirs without excessive cost in clearing the land of its occupants. The woodland also tends to regulate the run-off, and to prevent the silting up of the reservoirs.

The Cliffs power system includes six hydro-electric plants—one on the Michigamme River at Republic, one on the Escanaba near Gwinn, one on the Au Train, one on the Carp near Marquette, and two on the Dead River north of Negaunee. The first plant was erected on the Au Train in 1910, the second on the Carp in 1911, the last on the Escanaba in 1928. The Carp plant, equipped with two 3,700 h.p. generators, is located near the mouth of the river (Fig. 9). From it, the 66-inch penstock reaches 4 miles up stream to the dam, thereby obtaining a head of 600 feet. Still farther up stream is a large reservoir, which impounds 434 million cubic feet of water for use during seasons and years of low rainfall. The

[80] *Iron Ore*, March 9, 1929.

reservoir covers 1000 acres of cut-over land of low value. The McClure plant on Dead River has a penstock 2½ miles long, and a concrete intake dam with a storage capacity for several days operation. Since the construction of the McClure dam, the Hoist dam, with its enormous reservoir, was built to serve both the McClure plant and a new one at the Hoist. This reservoir reaches fourteen miles up stream, covers 4000 acres, and impounds two billion cubic feet of water, enough for the needs of the Hoist and McClure stations for one year. Taken together, the six plants can develop 14,000 kilowatts when all are operating at full capacity, and the annual rating is 60 million kilowatt hours.

The Cliff power system serves the Cleveland-Cliffs mines at Negaunee, Ishpeming, North Lake and Gwinn, and also sells power to other mining companies. It furnishes the electric current distributed by the Michigan Gas and Electric Company in Negaunee and Ishpeming, and that distributed by the municipal system in Negaunee. It also supplies the villages of Republic, Michigamme, Champion, Gwinn, Princeton, and Little Lake, and several smaller communities as well, with current. The success of the hydro-electric development is seen in the fact that the Michigan Gas and Electric Company and the City of Negaunee purchase current to supply their customers rather than operate their own carbo-electric plants. These stand idle but ready for use in case of emergency.

The availability of cheap electricity has made it possible to introduce more power-driven machinery, which in turn has caused an increase in the output of iron ore per man. In 1923, the Negaunee mines produced 4.04 tons per man, but in 1927, the tonnage had jumped to 6.07, an increase of 50 per cent in four years.[61] This marked advance was due primarily to the increased use of electrical equipment, particularly the scraper.

(5) In considering labor conditions at the mines, the geographer finds the aspects of chief interest to be (a) the present surplus of laborers, (b) the nationality of the laborers, (c) the specialization of labor in shaft mining, (d) the safety of the miner, (e) the irregularity of employment, and (f) the competition between the mine and the farm for the laborer's time.

(a) Today, there are perhaps 200 men in Negaunee who are unable to obtain employment at the mines, whereas it formerly

[61] These averages were compiled by F. G. Pardee, State Mine Appraiser, Lansing, Mich., for the writer.

was necessary for the operators to recruit laborers from among the immigrants at the eastern ports. Why this change from a shortage of labor to a surplus? Undoubtedly, the present stage of development of Negaunee is partly responsible. Negaunee being a mature mining town, there is no demand for additional miners to work in new mines or in extensions from those already in operation. Furthermore, the town has been settled long enough for the descendants of the early miners to furnish a labor supply. Perhaps the normal increase in the population would have been sufficient to create a surplus of labor by this time, yet it is certain that another factor leading to the same result has been the introduction of large amounts of power-driven machinery in the mines. Although the greatest advances have been made in the last seven years, the process of substitution of machinery for man power has really extended over the last two decades. Within this longer period, the number of men employed in the mines of Negaunee decreased about 36 per cent, although the amount of ore produced has remained practically constant. The decrease in the number of employees has been accomplished, in part, by allowing the older miners to retire without hiring others in their places, but there have been many able-bodied men permanently discharged from time to time because they were no longer needed. The results of this change in the demand for labor has been far-reaching. As it affects mining operations, it has tended to keep out inexperienced miners, and thus to decrease the number of accidents. It has forced many of the younger, more adventurous men to seek employment elsewhere, and so has steadied and sobered the life of the community, thereby intensifying the characteristics which tend to dominate the social life of a mature mining town.

(b) Not only are there fewer miners than formerly, but their nationality has radically changed. Years ago, the Cornish and the Irish predominated.[62] When the mines were first opened, native Americans were attracted from other parts of the United States,

[62] Nationality at three mines where more than 600 men were employed (1871): Irish, 31 per cent; Cornish, 27; Swedes, 18; French Canadians, 5; American, 5; Germans, 4; Norwegians, Danes, and Scotch, 10. Brooks, "Iron Bearing Rocks," *Mich. Geol. Sur.*, I (1873), 251.

Nationality of the men employed in the Jackson mine, Nov., 1885; Cornish, 91; Danes, 28; Irish, 23; American, 19; Germans, 9; Finns, 6; Swedes, 5; Canadians, 4; French, 3. Lawton, *Report Commissioner of Mineral Statistics, Michigan,* 1886, (Lansing), 29.

but "before long it was necessary to seek among the immigrants at the eastern ports, men accustomed to this class of work."[63] Cornish miners began to come at once, but were more numerous after 1870. The discovery of copper deposits in the Lake Superior Region, and the increased productivity of some of the Spanish copper mines caused a considerable fall in the price of copper; the Cornish copper mines, already near exhaustion, were unable to meet this competition, and "whole mining areas"[64] were closed. It is estimated that a third of the mining population left Cornwall between 1871 and 1881. These men furnished the captains, foremen, and a few of the unskilled workers, but most of the latter were immigrants unused to mining. The opening of the mines on the Marquette Range came about the time that famines in Ireland were causing a great exodus, so that many Irish immigrants came to the mines for employment. In the eighties, Swedish miners became more numerous, and in the late nineties, the Finns. In 1898, the Cambria and Jackson miners were mostly Cornish, whereas Finns and Swedes were predominant at the newer mines, such as the Negaunee and the Buffalo.[65] The last three decades have witnessed an influx of Finns and Italians. At the same time, the second and third generation of Cornish and Irish have displayed a tendency to forsake the mining towns for the larger cities of the Lower Lakes Region. Today, perhaps 50 per cent of the miners are Finnish, about 35 per cent Italian, and the remainder mostly Cornish and Irish. Despite the small number of Cornish miners, they furnish most of the captains and foremen.

(c) The specialization of labor in shaft mining is illustrated by the following statement of the labor distribution in the Negaunee mine. The shaft mines clearly offer a greater variety of tasks than the open pits did. On the other hand, the shaft mine is a more dangerous place in which to work, unless one finds employment at the surface.

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[63] Jopling, Jas. E., "History of Cleveland-Cliffs Iron Company," *Mining Journal* (Marquette), May 7, 1927.

[64] Jenkins, A. K. H., *The Cornish Miner* (London, 1927), 303.

[65] Annual Report, Bureau of Labor Statistics, Michigan, 1898, (Lansing), 286-8.

TABLE II

OCCUPATIONS IN THE NEGAUNEE MINE

Surface men employed			60
General labor	15	Engine room men	7
Carpenters	4	Timber framers	6
Machinists, Blacksmiths	4	Miscellaneous	24
Underground men employed			200
Miners	110	Plumbers, etc.	5
Timber hoisters	10	Timber crew	5
Motor crew men	24	Track crew	4
Road builders	8	Track cleaners	4
Pumpmen	3	Skip tenders	2
Captain	1	Samplers	2
Bosses	4	Miscellaneous	18
Total number of men employed in the mine			260

(d) Although shaft mining is a hazardous occupation, it is less so than formerly. Fatalities on the Marquette Range dropped from a yearly average of 4.57 per thousand for the years 1900-04, to 2.66 for 1916-19, and still lower to 1.43 for 1923-26.[66] The improvement has been most rapid since 1920. It has been due to greater care on the part of both the miners and the operators. The number of slightly and seriously injured men is more alarming. For each thousand employees, there was a yearly average of 31 serious injuries and 70 slight injuries during the period 1924-27. A serious injury is one resulting in a loss of 20 or more days of work; a slight injury, one involving more than one and less than twenty days.

From an analysis of accidents occurring over a period of several years certain conclusions have been drawn. (1) The injuries are due primarily to falls of rock and ore, and —in one exceptional case—to an inrush of water and sand. (2) Leading secondary causes are falls in shafts and other openings, and mishaps in the use of mining machinery. (3) Fire is not an important cause of injury—quite a different situation from that obtaining in coal mines. (4) Many of the accidents occur in so unavoidable a manner that mining inevitably breeds a fatalistic attitude. For example, many deaths from falls of rock occur where, only a short time before

[66] Computed from data given in the *Reports of the Inspector of Mines, Marquette County*. No figures are available for Negaunee alone, but as mining conditions are similar throughout the county, and as Negaunee has about a third of the miners, the ratios probably give a correct impression of the dangers present in the Negaunee mines.

the accident, the walls had been inspected and declared safe. It is quite common, too, for two men to be working side by side when a fall of rock kills or injures one and leaves the other unharmed.

In certain mines on the Range, the condition of the air is feared as much as injury from falling rocks. "Every day you work there, you drive a nail in your coffin" is a statement commonly heard. The Negaunee mines, however, are well ventilated. Fortunately, the rock temperatures are low, ranging from 50° to 60° F. On the other hand, the heat from decaying timbers greatly increases the temperature of the air. Furthermore, the relative humidity is nearly 100 at all times of the year, so that in the sublevels, where the temperature sometimes goes above 80° F., the men are subjected to sensible temperatures characteristic of the rainy low latitudes. A few minutes of exertion in some of the sublevels causes one unused to it to pant for breath, and the miners perspire freely as they work—this despite the fact that the mines are well equipped with fans and other devices for forcing a current of fresh air through the underground passageways. The improved ventilation and the small number of fatal accidents indicate a high degree of success, on the part of the operators, in coping with the dangers that surround the miner.

(e) Another unsatisfactory feature of mine work is the irregularity and uncertainty of employment. The inability to ship ore in winter causes many mines during that season to operate four or five days each week instead of six. As a result of the sensitiveness of the iron ore market to general economic conditions, the community suffers severely during nation-wide depressions. The exhaustion of ore of a marketable grade, or the closing of a mine for other reasons, throws a large number of men out of work. The following notes from the reports of the county inspector of mines reflect the uncertainty of mine employment:

> 1912. Mining industry bright at present. Maas mine resumed operations, new shaft being sunk at Lucky Star, new shaft completed at Rolling Mill, sinking shaft 300 feet deeper at Cambria No. 2.
>
> 1914. Milwaukee-Davis at Negaunee abandoned. Work suspended at Breitung, at Mary Charlotte No. 1, 2, at the Lucky Star, at the Maas.
>
> 1916. Mines working at full capacity.
>
> 1917. Jones and Laughlin Ore Co. has temporarily suspended operations at the Rolling Mill. Oliver Iron Co. has surrendered lease of the Prince of Wales mine.

1918. Prince of Wales abandoned by Breitung interests after working a short time. Athens added to the producing list.

1922. In June, 1921, heavy curtailment of mining operations, which was effective until June 1, 1922. The Maas, Negaunee, and Athens mines worked on a four-hour-a-day basis for this period, and the Rolling Mill and Mary Charlotte were idle the first part of the year, but placed on the active list before the close, whereas the Cambria was idle the entire year.

1923. Mining operation resumed at the Cambria. Negaunee mines have large accumulations of ore in stock.

1925. Many mines operating on four and five day schedule.

1927. Rolling Mill, underground mining suspended.

When the Mary Charlotte mine was closed in 1928, the seventy men employed were widely scattered. Some found work in other iron mines, some went to the Keweenaw Peninsula to work in the copper mines there, others secured odd jobs in the city, and still others sought employment in the logging camps of the Upper Peninsula. A few of the men lived on small farms, which enabled them to bridge the idle period until work was found.

(f) The competition of the nearby farm lands for the time of the miner is important in principle, though not very significant quantitatively. At the Cambria-Hartford mine, there are no miners who also farm, for they are all Italians, "and Italians do not farm this country." At the Mary Charlotte, there were only a few who had farms (1928), and they were all Finns: "Only the Finns[67] will farm this country" was the opinion of the superintendent. At the Athens, Maas, and Negaunee mines, from 3 to 6 per cent of the men have farms which they cultivate, and perhaps half of them live on their lands, one to three miles from the mine where they are employed. The Finnish farm district one and a half miles east of Negaunee illustrates the farm-mine (symbiosis). "Every man in the settlement works or has worked in the mines," and all the families but one have one or more men employed in the mines at the present time. The case of one Finnish immigrant is typical. His farm contains forty acres of rolling moraine land, all of which

[67] Of the miners of various nationalities, only the Finn is electing to farm the land. The explanation undoubtedly lies in the suitability of Finnish farming methods and ambitions and standards, inherited from the mother country, as an equipment for wringing a living from a hard land such as that which surrounds Negaunee.

is cleared except a little near a creek. In 1928, he had four acres in oats, a small potato patch, and the rest of the land in hay and pasture. He keeps seven milch cows and sells butter. Much of the farm work is done by his wife and children, for he is employed at the Athens mine, but he takes three weeks vacation from mine work each summer for "haying time." He has never tried to obtain his entire living from his farm, and thinks it could be done only by hard, indeed very hard work (despite the fact that his farm appears to be among the more favored ones in topography and soil). Undoubtedly, the forbidding character of most of the land within a radius of three miles of Negaunee has tended to minimize the importance of the farms as a factor in the labor situation at the mines.

(6) The operation of a shaft mine employing as many men as the Negaunee, or even the Cambria-Hartford, requires a large amount of capital. The pay roll for the Athens was $214,705 in 1927; for the Maas, $248,997; for the Negaunee, $382,842; and for the Cambria-Hartford, about $120,000. The investment is large, too. The sinking of the shaft may cost a million, more or less; the shaft head costs about $12,000; the ore trestle, about $60,000; the change house, $12,000 to $18,000; the air compressor, $12,000; the shops, $35,000, and so on.[68] If the operator of the mine owns the ore body, his investment is enormously increased. In 1927, the Athens property was evaluated for taxation purposes at $3,148,000, and the Negaunee at $6,103,000. The mining companies pay taxes on property at Negaunee valued at $16,279,700 (1926)—88 per cent of the taxable property of the city.[69]

The Negaunee mine is held jointly by the Cleveland-Cliffs Iron Company and the Bethlehem Steel Company, and a similar arrangement exists between the Cleveland-Cliffs and Pickands, Mather, and Company in the operation of the Athens, whereas the Maas lease is held by the Cleveland-Cliffs alone. The Republic Iron and Steel Company operates the Cambria-Hartford. Each of these is a corporation with far-reaching business connections. The Cleveland-Cliffs, for example, owns or controls a large share of the iron mines and iron ore resources of the Marquette Range, has holdings

[68] Bonnell, E. S., "Surface Equipment for Iron Mines," *Iron Ore*, Oct. 6, 1923.

[69] Data from a statistical study, "Taxation in Negaunee," by R. A. Brotherton, Civil Engineer, Cleveland-Cliffs Iron Co.

on the Gogebic and the Mesabi Ranges, and owns coal mines in the Appalachians and timber lands in the Upper Peninsula. It developed and operates the Cliffs power system, has a fleet of ore boats on the Great Lakes, owns charcoal furnaces in the Upper Peninsula, and has a controlling interest in certain blast furnaces and steel mills in Cleveland and Massilon, Ohio.

These modern corporations, with their great financial strength and their elaborate transportation and marketing facilities, have reduced appreciably the irregularity of employment so characteristic of most mining towns, and to that extent have bettered the condition of the miners. The present-day mining company is an organization which cannot remain idle for a part of the year without incurring great expense. The marketing connections tend to guarantee an outlet for at least a part of the ore even when there is a mild depression. And if the market suffers a serious collapse as it did in 1921 the companies are strong enough to continue mining operations for a part of each week, and to allow the ore to accumulate on the stock piles.

(7) The market price for iron ore has been relatively low during the last few years. Although the mines are deeper than they were 20 years ago, with wages about twice as high and the cost of materials and supplies about twice as great, yet the price of ore is only about 10 per cent greater now than then.[70] As a result, many of the less efficient underground mines have suspended operations (e.g., the Mary Charlotte), and the better ones have been forced to a new level of efficiency. The relatively low price of ore is declared by the operators and others to be due to the over-developed condition of the iron-mining industry in the Lake Superior Region, and to the competition offered by the cheaply mined ores of the Mesabi open pits.

The over-development of the iron-mining industry in the Lake Superior Region is pronounced. The production in 1925 was 30 million tons, whereas the region was equipped to produce 86 million tons.[71] Although this situation is due in part to the general tendency of business toward over-expansion during good times, there are at least three other factors involved. First, iron mining

[70] Mather, S. L., "The Iron Ore Industry and Some of Its Problems," *Iron Ore*, December 22, 1928.

[71] Barrett, L. P., State Appraiser of Mines, in *Negaunee Iron Herald*, May 22, 1925.

was stimulated by the World War to a level of production greatly in excess of peace-time needs. Secondly, the Lake Superior ores are being gradually crowded from the Atlantic seaboard by imported ores. In the third place, changes in methods of steel-making have tended to cut down the demand for pig iron, and, as a result, for iron ore. When the Bessemer process was almost universal, little or no scrap steel was used, whereas in the open-hearth process now chiefly employed, about 50 per cent of each charge is scrap steel. Because of differences in production costs, the underground mines have felt the depressive effect of this over-development more keenly than have the open pits.

The difference between the cost of producing iron ore in the underground mines of the Marquette Range and in the open-pit mines of the Mesabi is surprisingly large. The average cost on the Marquette Range was $2.004 per ton in 1927. The cost at the Negaunee mines certainly differs little, if at all, from that figure. The average cost in the Mesabi open pits was $0.764 and "there are numerous Mesabi Range mines which put their ore on cars for 50 to 60 cents." [72]

The Negaunee mines, together with other Michigan underground mines, would be forced out of the market if it were not for certain significant advantages, both natural and economic, over the Mesabi open pits. (a) The shorter rail and shorter lake haul to market gives a saving in shipping costs—34 cents per ton in 1928. (b) The Michigan ore commands a higher price because it is cleaner than the Mesabi product, and because it is needed to mix with the Mesabi ore in the blast furnace. The differential, at one time as high as 75 cents, is now 15 cents per ton. (c) The Marquette Range operators pay lower royalties. This saving was 28 cents per ton in 1927. (d) The Michigan tax rate is much lower than that in Minnesota, a difference of about 35 cents per ton during recent years. As a result of these savings, the Marquette ore can be delivered at lower lake ports at about the same total cost as that from the Mesabi pits. It should be remembered, however, that the present low cost of underground mining ($2.00 per ton) has been attained only by the introduction of many economies. Probably these improvements are as important as the advantages just enumerated in enabling the Marquette mines to meet the Mesabi competition.

[72] Data for the Marquette Range from Report, State Tax Commission, 1927 (Lansing); for the Mesabi from *Iron Ore,* Oct. 26, 1929.

In marketing the ore, close attention is given to its chemical composition, which varies widely. The furnace operator must know the percentage of iron and of silica and other impurities in order to secure satisfactory results. The desired composition is generally stated in the purchase order. It is necessary, also, to know the composition in order to determine the price. Premiums are paid for ore high in iron and low in phosphorus. The Bessemer ores, those containing less than .045 per cent phosphorus, sell for 15 cents per ton more than the non-Bessemer (1929). The ore is sampled at the mine and again at the receiving port. The first sampling serves in classifying the ore and in mixing it to secure a cargo of a given composition. The second sampling is used to determine the price. The average composition of the ores shipped from the Athens, Maas, Negaunee, and Cambria-Hartford mines in 1926 is given in Table III.

TABLE III[72]

AVERAGE COMPOSITION OF CARGOES SHIPPED FROM NEGAUNEE MINES, 1926

	Iron	Phos.	Silica	Mang.	Alum.	Lime	Mag.	Sul.	Loss	Moist.
Athens	53.24	.111	4.87	.41	2.47	.87	.82	.012	1.31	13.00
Cambria										
Cambria grade	51.91	.072	8.78	.23	2.28	.66	.35	.024	2.14	11.00
Violet grade	52.28	.037	8.71	.16	2.82	.83	.43	.023	2.24	10.05
Maas										
Maas grade	53.10	.094	6.90	.248	2.44	.97	.40	.011	1.95	11.50
Maas Bessemer	54.16	.041	7.17	.222	2.15	.58	.25	.008	1.28	11.50
Negaunee										
Negaunee grade	53.10	.088	6.11	.248	2.51	1.06	.43	.010	2.08	11.50
Negaunee Bessemer	55.09	.042	4.47	.248	2.22	.797	.32	.009	1.33	11.50

The Future of Mining in Negaunee.—The future of mining in Negaunee is full of uncertainties. The extent of the high grade ore is unknown, and there is no great incentive for the mining companies to increase the proved reserves beyond what is necessary for efficient planning of mining operations. The irregular shape and distribution of the ore bodies, as well as their relatively great

[72] Crowell and Murray, *Iron Ores of Lake Superior* (Cleveland, 1928).

depth below the surface, make computations from diamond drill data somewhat untrustworthy. Moreover, the present practice of taxing the ore reserves instead of the output makes it unwise for the companies to explore beyond their present needs. Efficient mining on the Marquette Range requires that the proved reserve supply be large enough to permit the operator to make his plans for production and marketing for 15 years ahead. A larger assured reserve than that increases the taxes without being of corresponding value to the operator. The future is made uncertain, also, by the possibility of changes in demand. If the demand for iron ore should increase, the resulting increase in production would shorten the life of the mines. If the demand for low grade ore and ore of high sulphur content can be stimulated, the salable ore resources of Negaunee will be greatly increased.

Another unknown factor is the effectiveness of competition from other fields. A drop in the iron content of the ore would probably bring the low grade Appalachian ores again into prominence. Further, the lower the iron content, the higher will be the transportation charge per unit of metallic iron. This handicap might be sufficient to allow effective competition from foreign ores on the lower lakes market. Davis argues that should the transportation cost per unit of metallic iron be materially increased, the capital invested in the Lake Superior Region is likely to flow to competing areas, thus robbing the former of what he holds to be its chief advantage today—the enormous amounts of capital invested there. He concludes: "The wonderful transportation systems, ore handling and dockage equipment, organizations and capital of the Lake Superior district are now available and ready to assist in prolonging the life of the iron-ore industry. In this respect, the Lake Superior district has great advantage over many other mining regions, but capital is very mobile and railroads and docks can be allowed to deteriorate and as the future ore supply becomes more and more uncertain, this great advantage may gradually disappear." [74]

Despite the uncertainties involved, the inhabitants of Negaunee are strongly optimistic about the future of the mines. This attitude is based, primarily, on the assumption that the Negaunee-Maas ore body extends beneath the city to the western boundary, a belief well supported by fact, for the ore body dips in that direction, and

[74] Davis, Edward W., "The Future of the Lake Superior District as an Iron-Ore Producer," *Minn. Sch. of Mines,* Exp. St. Bul. 7 (1920), 4.

diamond drilling has disclosed what is presumed to be a continuation of it 3000 feet below the surface and a mile west of the present workings. The presence of other ore deposits within the city limits, particularly the Breitung, and the possibilities which unexplored structures hold contribute to the feeling of optimism. The inhabitants of Negaunee very naturally assume that the city has a large proportion of the iron ore resources of the Marquette Range. Data for assured tonnage on the Range indicate a supply that will last 20 years, and the estimates of probable resources place the prospective life of the mines at about 50 years. Lake,[75] who made a thorough study of the situation, holds that these estimates will be increased as the years pass, and Royce[76] concludes that the life of the Marquette Range gives promise of being longer "by far" than that of any other of the Lake Superior ranges, not even excepting the Mesabi. Perhaps the two statements, "There will be mines operating in Negaunee 50 to 75 years from now" and "Some day this will be nothing but a Finnish farming community," accurately reflect the general opinion of the more observant inhabitants of Negaunee regarding the immediate and the remote future.

Conflict of Mining with Other Land Uses.—In the abandoned mine areas, the land is used, if at all, for grazing. It is too rough and stony for crops, and too dangerous and unsightly for residential use. There is not sufficient need for additional agricultural and residential land to justify the expense of filling the pits and caves and removing the piles of waste rock. The same obstacles would be met if an attempt were made to use the land for business sites. Transportational uses, however, present a different problem. The road represents such an imperative need and occupies such a narrow strip of ground, that, despite the difficulties involved, it tends to cross abandoned mining lands, provided there is no easy alternative route. The western extension of Iron Street, for example, crosses the Jackson pits with the aid of a fill and concrete retaining walls.

Where the mines are not abandoned, roads cross the properties on sufferance. The highway which leads to Palmer crosses the Rolling Mill property between the shaft and the stock pile. Here,

[75] Lake, M. C., "The Future of the Lake Superior District," paper read before the Lake Superior Mining Institute, 1924.

[76] Royce, Stephen, "Certain Advances in Geological Information Relative to the Lake Superior Iron Deposits," *L. S. M. I. Proc.*, 24 (1925), 174.

caving of the ground had made frequent repairs necessary. When the City planned to repair the road recently, thus tending to make it a permanent thoroughfare, the owners of the mine objected, and sought a court injunction against the City. In the court decree, it was declared that the City had a right to maintain the roadway, subject to removal if and when the mining company should need the land. The court stated, further, that its decision rested on the basic principle that "the ore in the ground merits first consideration." In formulating this principle, the court was held by the local press to have established a new mining law.[77]

The conflict between the saxicultural and other types of land utilization becomes more serious where active mining encroaches on land already devoted to other uses. In 1907-8 and again in 1927-29, the expansion of the Maas-Negaunee district forced the removal of houses and the relocation of roads and railroads.[78]

The mining company was reluctant to initiate the first removal, for it was not generally recognized at that time that caving of the surface must inevitably follow the extraction of the ore. The mining engineer, who had recently spent a year in Europe, was convinced from what he had seen in the Belgian coal fields that, even though 400 feet of jasper and more than a hundred feet of sand overlay the ore body, caving would eventually follow mining. He finally persuaded his employers that the land must be vacated. A railroad crossing the property was relocated south of the mines. A detour in the Marquette highway enabled it to avoid the area to be caved, yet allowed traffic to enter the city as before by way of Main Street. The houses were moved westward to new sites and the city cemetery was relocated more than a mile east of its original site, on a fairly well-drained portion of the Eagle Mills terrace. No great opposition to undermining this section appears to have been encountered by the mining company: a part of the ore was owned by private individuals who benefited by its exploitation, only a few houses had to be moved, and the relocated portion of the highway allowed the inhabitants to enter the city along the usual

[77] *Iron Ore,* July 28, 1923.

[78] The discussion of the first removal is based on information furnished by James E. Jopling, the engineer to whom reference is made, and on maps from the Cleveland-Cliffs Iron Company. The second removal took place while field work was in progress, and the conflict was closely followed through personal interviews and the study of accounts in the local newspapers.

course. The new site of the cemetery was clearly superior to the old, already marred by mining operations on adjacent lands, and the owners of the old cemetery grounds received payment for the underlying ore.

The second removal was essential to maximum production in the Negaunee and Maas mines, and promises to be of great benefit to the city. Underlying the area to be vacated (Fig. 2) are more than 7 million tons of iron ore, enough to permit both mines to continue at the present production rate for at least ten years, a relatively long time in the life of an iron mine. If the area were not vacated, the operators would soon be forced to discharge about 280 men—35 per cent of the miners of Negaunee—and would eventually have to close the mines. Theoretically, the company could mine the ore without first securing the surface rights, but experiences in other mining towns have shown that the damage suits which follow such a course may amount to millions of dollars. Despite the fact that the community would have suffered severely had the two mines curtailed operations, the project met with considerable opposition from both private individuals and from the city council, an opposition motivated apparently by the desire to force the company to pay dearly for the surface rights.

The first encroachment of the Maas-Negaunee district occurred 20 years ago. If the mines operate at their normal rate, the ore made available by the recent removal will have been mined in ten to fifteen years. For the third time it will be necessary to move houses and close streets if the mines are to continue operating. And perhaps the third removal will be followed by a fourth and a fifth. The inhabitants confidently expect this to be the course of events. It is a commonly expressed opinion that "the entire city will have to be moved some day." As a matter of fact, only the central residential district and the commercial district will be affected if the encroachment continues.

The occupation of this mineral land by residences resulted from incomplete geological knowledge—this part of Negaunee was thought to overlay barren slates. Doubtless this maladjustment would not have occurred if the area had been a non-glaciated one, for in that case the iron formation would have been exposed. There is ample room north and northeast of the Maas mine where a city of this size could have been located had the necessity for vacating so much of the present site been foreseen.

The Residential Districts

At every stage in the evolution of Negaunee, the residential landscape has reflected the status of the mining industry. Associated with the first crude quarry was an equally primitive log cabin. A little later, a cluster of six cabins indicated the persistence of a feeble mining industry. As new mines were opened, additional clusters and rows of houses were established near them. Presently, the growth of population permitted the development of a central residential district, dependent on the mining industry but relatively independent of individual mines. The two periods of most rapid growth in the mining industry, 1855-70 and 1885-1910, witnessed marked expansion of the residential areas. More recently, the abandonment of certain outlying mines has caused some of the locations to be partially deserted, and the encroachment of the Negaunee-Maas mining district on the central residential area has brought notable changes in the street pattern and in the distribution of houses.

The Central Residential District.—Nearly three-fourths of the dwellings of Negaunee are located in the central residential district ("9," Fig. 13), which occupies the western margin of the Negaunee outwash plain and extends westward between Jackson and Teal Lake hills (Figs. 1, 13). Variations within this district enable one to recognize several sections. Chief of these is the Main Street section ("f," Fig. 13), which contains nearly half of the houses of the district.

The Main Street section is almost coincident with the Pioneer plat, which was the first area platted in Negaunee for residential purposes. The original street pattern, with its peculiar orientation, has survived, and the original building lots, 50 feet wide, have remained the units of surface ownership. The surface rights to nearly all of the lots, 94 per cent of them, are owned by private individuals, for the Pioneer Iron Company freely sold these rights when the plat was laid out and neither that company nor any other mining company has since bought them from the individual owners.

As anticipated by its founders, the Main Street section became the residential core of the city, a position it continues to hold. The site, a portion of the well-drained, flattish outwash plain, was excellent, and the fact that the surface rights could be purchased was doubtless an attractive feature to men who were able to build homes of at least moderate size. Today, cottages of four rooms or less

constitute only one-tenth of the dwellings (Table IV), five-tenths are two-story buildings of 4 to 6 rooms, and the remainder are still larger. Practically all of the houses are built of wood, and most of them are well painted, in fair to good repair, and set in well-kept lawns. Although there are two houses instead of one on many of the individual lots, nowhere are the buildings packed so closely together that they touch each other. The best residences are located along Main Street, where the wealthier people live—the mining engineers, superintendents, and other salaried mine employees, and those who own valuable mineral rights or have owned them in the past. The rest of the section is occupied, for the most part, by professional men, merchants, and railroad employees. The miners who live in this section have homes near its margins.

Northeast of the Main Street section are five sections which were platted from the "strip farms" originally sold by the Pioneer Iron Company to French-Canadian woodchoppers. These sections were the first to feel the attack of the encroaching mines. The Grand Avenue section ("9a", Figure 13), once occupied by miners who worked in the mines of east Negaunee, has been vacated (Fig. 4). The Park Street section ("9b") will also be vacated within the next few years. The Elm Street section ("9c"), to which about 90 houses were moved, is really a location held by the Cleveland-Cliffs for its employees. This new section is in better condition than the Cherry Street section just south of it ("9d"), for the houses in the latter are in need of paint and are otherwise in poor repair. The Prince Street section ("9e"), set off from the others by a ravine, contains houses which are in fair to good condition. Though differing noticeably from one another, the four sections now occupied are similar in that they are all located on the flattish Negaunee plain, and are inhabited by miners most of whom are Finns.

On the northwest margin of the Main Street section lies the Bluff Street section along the southern slope of Teal Lake Hill ("9g," Fig. 13). Two-fifths of the dwellings in this section are cottages, and the remainder are small two-story buildings. Many of the houses lack basements, a result of the ice-scoured condition of the slope. Immediately south of the Bluff Street area is the valley floor of Partridge Creek ("9h," Figure 13), where small, somewhat inferior buildings are found.

The two sections south of Partridge Creek, "i" and "j" in Figure 13, occupy the two hills which are located just north of Jackson Hill (Fig. 10). They are separated from each other and from

TABLE IV

THE SIZE AND CONDITION OF DWELLINGS BY RESIDENTIAL DISTRICTS

Residential District	Key to map, Fig. 13	Size of Buildings					Condition of Buildings			
		Cottages, 4 rooms or less	Small 2-story bldgs., 5-6 rms.	Moderately large 2-story bldgs., 7-9 rms.	Exceptionally large bldgs., 10 rms. or more	Duplex or tenement bldgs.	Excellent	Fair to Good	Poor	Falling to pieces
Central residential district										
Main St.	9f	47	223	125	18	15	101	256	64	7
Grand Ave. (Vacated, 1928-29)										
Park St.	9b	5	31	23	0	0	5	43	11	0
Elm St.	9c	16	52	14	0	2	0	84	0	0
Cherry St.	9d	17	50	6	0	1	1	51	21	1
Prince St.	9e	3	25	7	0	1	5	26	5	0
Bluff St.	9g	20	31	2	0	0	8	38	6	1
Partridge	9h	12	18	0	0	0	2	12	15	1
Brown-Barns	9j	16	20	0	0	0	0	16	17	3
Merry St.	9i	22	73	12	1	9	21	77	23	2
Furnace	9k	2	6	0	0	0	0	6	2	0
Teal Lake Rd.	14	6	15	0	0	0	4	11	4	2
Arch St.	13	1	13	0	0	0	0	13	1	0
Southeast of Teal Lake	12	0	3	0	0	0	0	0	1	2
East of Teal Lake	11	0	0	2	0	0	0	0	0	2
Teal Lake Hill	—	1	3	0	0	0	0	3	1	0
Mary Charlotte	3	0	1	0	0	10	0	10	1	0
Cambria	18	21	6	0	0	0	2	11	13	1
Cornishtown	15	25	6	0	0	0	2	11	18	0
Pioneer	17	11	3	0	0	0	0	9	4	1
Prince of Wales	4	1	5	0	0	0	0	4	2	0
Rolling Mill	8	13	18	0	0	0	3	13	13	2
Buffalo	7	13	8	0	0	0	2	8	10	1
County Road	10a	25	21	0	0	0	9	29	8	0
Blue	4	5	3	0	0	0	0	1	4	3
"Old" Mary Char.	2	0	1	0	0	0	0	0	1	0
Ann St.	5	6	31	6	0	2	0	20	23	2
Patch Loc.	10b	10	16	1	0	0	0	20	6	1
Gaffney Loc.	7	7	8	0	0	0	0	6	5	4
Power House	16	0	4	0	0	1	0	2	1	2
Boyer Ave.	—	0	8	1	0	0	0	7	1	1
East of Pr. of Wales	—	1	1	0	0	0	0	0	2	0
Total, 1268		305	704	199	19	41	165	781	283	39

adjacent areas by railroads which follow the valleys (Fig. 2). The smaller of the two, the Brown-Barns section, is located on land owned by the Cleveland-Cliffs Iron Company. The houses are small and in poor condition. The larger or Merry Street section is privately owned, and is occupied by moderately large buildings. In these respects it resembles the Main Street section. Both the Brown-Barns and the Merry areas are inhabited by English rather than Finnish people.

Districts North of Teal Lake Hill.—North of Teal Lake Hill and near the east end of the lake are four small districts, which, unlike the other outlying residential areas, are not related to any particular mine. The largest (Fig. 13) is a neat, well-kept district of small dwellings, most of them located between the lake shore and the lake shore road. A somewhat less attractive district ("13," Figure 13), is located on the north slope of Teal Lake Hill where one might expect an excellent view of the lake and the wooded hills beyond, but that view is shut off by a high railroad embankment, which converts an otherwise attractive site into a somewhat uninviting pocket. Both of these districts are occupied, for the most part, by Swedish people.

At the east end of Teal Lake are two small residential areas, with three houses in one ("12," Fig. 13), and two in the other ("11"). The houses, apparently abandoned for years, are falling to pieces. Probably they are relics of the day when a thriving saw mill was located on Teal Lake.

The Locations: Residential Districts Associated with Specific Mines.—Three major groups of locations were recognized: (1) locations dependent on nearby mines, (2) locations associated with abandoned and idle mines on which they no longer depend, and (3) locations not logically classed in the first two groups. These groups are in turn divided into important sub-groups, or types.

(1) In the first group, three distinct types are found in Negaunee. (a) The Cleveland-Cliffs location (Elm Street section of the central residential district) is a "planned location" made up of houses of varied architecture. The buildings are owned by the company and rented to miners who work in the adjacent Maas mine, and in the Athens and Negaunee mines not far away. All of the houses in this area have been moved once and many of them twice. (b) The Mary Charlotte location ("3," Fig. 13) consists of eleven houses, ten of them monotonously alike, and arranged in

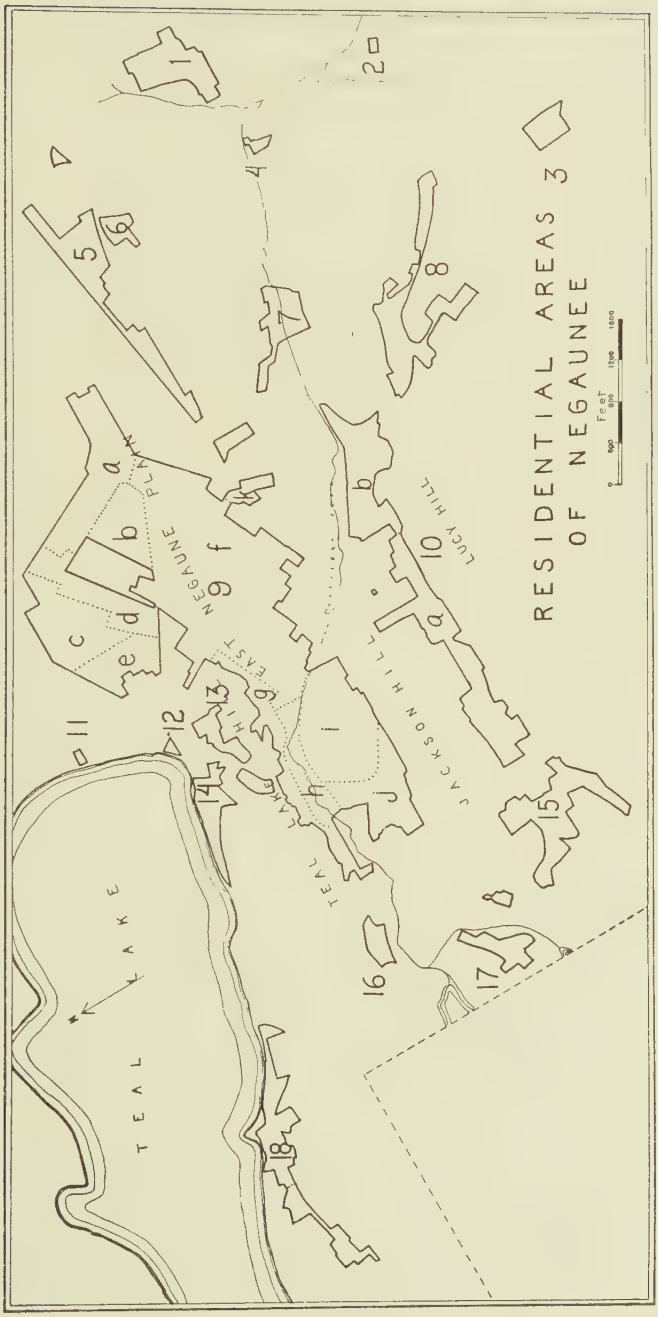
RESIDENTIAL AREAS
OF NEGAUNEE
Feet
TEAL LAKE
TEAL LAKE
NEGAUNE PLAT
NEGAUNE EAST
JACKSON HILL
LUCY HILL

FIG. 13.

two rows, separated by a strip of land which serves as a roadway and a playground. Each house is double, with six rooms on a side. The houses are owned by the mining company, and rented to miners who work in the Mary Charlotte mine nearby.[79] (c) Unlike these planned locations, the Cambria grew up in haphazard fashion. The lots are irregularly shaped and the buildings are strikingly varied. Forty per cent of the dwellings are log cabins, built when the mines in the Cambria-Lillie district were first opened. Some of these have been repaired and are still occupied, others are falling into ruins. Most of the recently built dwellings are small frame cottages. Some of the buildings are owned by the mining company, while the others —on land leased from the company—are the property of miners. The men are employed in the Cambria-Hartford mine just east of the location.

(2) Some of the locations associated with idle and abandoned mines have remained important residential areas, but others have declined. Both vigorous and decadent locations are well represented in Negaunee.

(a) An excellent illustration of the vigorous location is Cornishtown ("15" in Figure 13). It originally depended on the Jackson mine, but all of the men now work elsewhere. The houses, nearly all of them small cottages, were built on well-drained morainal land between rock knobs and south of them. A recent addition is the garage, and in some cases it is almost as big as the dwelling to which it belongs. The morainal slopes of gentle gradient furnish good garden and hay land. Some of the families own cows which graze on the steeper, rocky slopes in summer, and are kept in tiny barns in winter. The knobs also furnish a small amount of firewood. In winter, the cottages are almost hidden in snow, the boys learn to ski on the steep slopes of the knobs, and the men walk to and from their working places, for their cars are then used but little if at all. The location is favorably situated for continued occupancy, being not far from the heart of the city and on the main road to Ishpeming where doubtless some of the men find employment.

[79] When the Mary Charlotte mine was closed in 1928, many of the miners moved away from the location, although the company permitted all who continued to pay the rent to remain. By October, 1929, less than half of the dwellings were occupied, some of them by families whose men were working in distant mining towns. The houses not in use have been boarded up.

Other vigorous locations associated with idle or abandoned mines are the Pioneer ("17," Fig. 13), the Prince of Wales ("4"), the Rolling Mill ("8"), the Buffalo ("7"), and the County Road ("10a"). None of these has experienced recent changes except the Rolling Mill. It was a "deserted village" for a time after the mine was closed, but all save one of the houses are now occupied. In each of these locations, there are signs—a recently repaired roof, or even a new dwelling—that the location is not declining, despite the fact that the local mine no longer supports it.

(b) Two examples of the decadent location associated with idle or abandoned mines are found in Negaunee—the Blue ("4," Fig. 13) and the old Mary Charlotte ("2," Fig. 13). The Blue, hemmed in between a railroad on one side and Partridge Creek and some abandoned mines on the other, contains eight dwellings, one of them in good condition, four in poor repair, and three falling to pieces. Unsightly foundations indicate that the number of buildings was larger at one time. The Blue illustrates one way in which a location dies—by the decay, the abandonment, and, finally, the destruction of its houses, without the erection of others to take their places. The old Mary Charlotte, the most isolated of all the locations, has shrunken until only one house remains. Evidently this location was too far from other places of employment to serve as a general residential district. The Blue, on the other hand, is well situated to function in that capacity, but it is disastrously handicapped by an inferior site.

(3) Three important locations are properly termed "mixed" types, in that they represent gradations between those in groups (1) and (2). Ann Street location ("5," Fig. 13) lies between the Athens and Maas mines, and houses employees of both mines. It is also related to the abandoned Lucky Star and the abandoned mines farther east. When these mines were operating, men who "thought the town would grow in that direction" built houses along the road leading to the mines. The houses are now in poor repair, and about one-fifth of them have the second story vacant. Patch location is evidently so-called because it is a patchwork of houses between roads and railroads ("10b," Fig. 13 and Fig. 2). Some of the houses clearly date from the time when the mines on Lucy Hill, immediately south of the location, were operating. Others were doubtless built by miners who worked in the Breitung mine. Today, the location is probably supported in part by the Athens mine, just across the Partridge Valley. On the opposite side of

the Partridge Valley from the Patch location is the Gaffney ("7," Fig. 13), which, like the Patch, is related both to abandoned and to active mines. It more closely resembles the Blue location, however, for most of its buildings are in very poor condition, and four of them (out of fifteen) are falling to pieces.

The Location as a Geographic Unit.—As suggested in the preceding discussion, the location is a geographic unit. This appears in the form, structure, and functions of the location, and is in part the cause, in part the result, of the ethnic and social unity of the inhabitants.

The landscape pattern of each location is characterized by marked unity. The average location is small enough for uniformity to exist in the physical characteristics of the site. The street pattern is similar throughout—a natural result of the homogeneity of the site and the circumstances surrounding the origin of the location. The lots are alike in size and in regularity of shape. If gardens exist, they are found on every lot. The dwellings are likely to differ from one another somewhat, but there is always one type that is dominant, in most cases the cottage or small two-story building, and most of the buildings resemble one another in their condition of repair. The unity of the landscape pattern is accentuated by the presence of pastoral, agricultural, and saxicultural land surrounding each location and separating it from its neighbors.

Each location originated in the need for residential land near a particular mine or group of mines. The site remained in the possession of the mining company and the houses were built by it or by miners on lots leased from the company. So long as the mine which called a given location into being continues to operate, the inhabitants respond in a body to its varying fortune. If the ore is exhausted or the mine closes for some other reason, then the men must seek work elsewhere. Thereafter, the location is not likely to react as a unit to adverse developments in any one mine. Nevertheless, it continues to be primarily concerned with the mining industry, on which nearly all of the inhabitants of Negaunee directly or indirectly depend for a living.

In a given location, most of the inhabitants are of the same nationality, Finnish, Italian, or English (Cornish), as the case may be. This ethnic individuality appears to have grown out of the attraction which the mines have had for immigrants of different nationalities, and the tendency for immigrants of the same nationality to crowd together. The physical isolation of each

location has probably tended to maintain the dominance of some ethnic group in each, by preventing free mingling with peoples of alien customs and speech. The immigrants have thus been separated by both cultural and natural barriers.

The ethnic unity of the location fosters social unity, for each nationality has its own social customs, its mother tongue, its fraternal order, and its religious inclinations. The Cornish belong to the Odd Fellows, and Sons of St. George, and to the Methodist Church; the Finnish to the Order of Kevala and to Protestant churches; the Italians to the Knights of Columbus and to the Roman Catholic Church. The linguistic and social unity of the location, together with its isolation, has in several cases favored the establishment of a local school. The Cambria has one, and so has the Rolling Mill. The Jackson school (in the Merry section of the central residential district) was built to care for the children of the miners employed at the Jackson pits. Commonly, however, each school is made to serve two or more locations, and some locations have no schools nearer than those in the Main Street section.

Though the typical location is strongly unified in several ways, it is far from self sufficient. It has no stores and no churches, social welfare work is directed from more central points, and the parochial school and city high school are located in the Main Street section. These mutual interests, together with common dependence on the mining industry, bind all of the residential areas together.

Types of Dwellings in Negaunee.—The significant types of dwellings found in Negaunee are (1) the log cabin, (2) the palatial home, (3) the company house of uniform architecture, and (4) the four to six room frame building of simple but varied style.

(1) The log cabins are survivals from the youthful open-pit period. Most of them have been modernized by covering the logs with plaster and by adding a small room of boards, roofed with corrugated sheet iron. All of the cabins that have not been remodeled, and some that have been, are idle. There are eleven of them in all, less than 1 per cent of the houses in Negaunee.

(2) The palatial homes, of many rooms and elaborate grounds, are a more recent response to the mineral wealth of the city. In them live men who have derived their wealth from the mines.

(3) In contrast to the individualistic character of the palatial home is the uniform architecture of the company house in the Mary Charlotte location, the only place in Negaunee where such

buildings occur. It is commonly true of mining towns that a large portion of the houses are of this type. Why do they constitute such a small proportion—less than 1 per cent—of the houses of Negaunee? The unusual situation is due primarily, if not entirely, to four causes. (a) Negaunee has been settled too long for many of the original structures built by mining companies to survive. (b) The mines have furnished relatively steady employment for so many decades that the miners have been willing to build their own homes, thus making it unnecessary for the mining companies to do so. (c) The mines have been near enough to the central part of the city and to each other for miners to build homes in the locations and in the central residential district with the expectation that when the adjacent mine should close the house could be used by some one working elsewhere. (d) The principal companies have encouraged the miners to build their own houses by selling them land on easy terms or by leasing it to them at a nominal rental. Naturally, each man has made his house a little different from those of his neighbors.

(4) The most common type of house is the small four to six room frame building. In general, these houses need a coat of paint, but appear otherwise in fair repair,—if one except the houses in the decadent locations. A compact, box-like style is generally adopted. Such a house is heated easily, a matter of importance in this land of long and cold winters, and there are few troughs in the roof where snow might collect. Perhaps half of the houses have moderately large porches, a maladjustment, it seems, for the summers are so cool that porches are of little use. Outside of the Main and Merry Street sections of the central residential district, this type of house is built on land owned by a mining company, so there is little incentive to build a costly house, or to make permanent improvements in the site. About three-fourths of the houses in Negaunee are of this type.

A type that is not common in Negaunee is the empty house with boarded windows and doors. A few are found, but probably no more than commonly exist in commercial cities of similar size. Negaunee has not reached the stage where rapid decline in mining empties a large proportion of the houses.

Localization of Dwellings.—The localization of groups of dwellings in Negaunee is related primarily to the position of the roads and railroads, the distribution of favorable land forms, and the known or supposed location of ore bodies.

Roads have attracted dwellings, while railroads have repelled them and limited their areal extent. The road leading to Ishpeming (foreground, Fig. 1) is lined with houses, and the main highway to Marquette has been a favorite locus of houses ever since it was laid out as the Plank Road in the infant open-pit period. On the other hand, land next to the railroads has been avoided whenever practicable. In the Main Street section, the lots bordering the railroad were among the last to be occupied. The railroad has also served as a barrier to the expansion of residential sections. This is most noticeable on the northeastern margin of the city, where the Lake Superior and Ishpeming Railroad forms the northern and eastern boundary of the central residential district despite the occurrence of more attractive lands beyond the railroad.

Dwellings have been placed, in most cases, on well-drained lands of less than 10° slope—on flattish and gently sloping outwash, or on gently sloping moraine. Steeply sloping outwash and moraine, ice-scoured knobs and slopes, and poorly-drained valley bottoms (Fig. 10) have been avoided. Years ago, a few houses were placed on such sites, but they have been abandoned or allowed to run down. With a notable exception—the outwash plain of east Negaunee—the favorable land forms have been secondary rather than primary factors in localizing residences. The desire to be on a given road or near a particular mine has been the chief consideration, and the land forms have been considered in choosing the exact site along the road or near the mine.

The most important factor localizing the dwellings of Negaunee has been the known or supposed location of ore bodies. The mines have attracted workers, and the latter have established homes near them. At the same time, the areas preempted for surface operations at the mines, or caved by the removal of ore, or even held for future mining, have not been available for residential occupancy. Mining has been responsible, too, for the relocation of many residences, by the removal of economic support through exhaustion of the ore body or suspension of mining operations for other reasons, and by the encroachment of mining on residential areas. The decline of the "old" Mary Charlotte and the Blue locations illustrates the effect of mine abandonment and the recent removal of ninety houses in eastern Negaunee illustrates that of mine encroachment. The mining companies no longer sell or even lease prospective mining land for residential sites. As a result, future residential sections, if any develop, are likely to be located north

of the central residential district, outside of the area underlain by the iron formation.

The pattern of the residential areas (Figs. 2, 13) reflects these three major localizing factors. The irregular distribution of the districts is due primarily to the irregular distribution of mines and of favorable land forms. The adjustment to roadways is seen in the elongated character of the districts, and their irregularity of outline reflects proximity to non-residential land—rock knobs, steep outwash and moraine, poorly-drained valley bottoms, and land occupied by mines and railroads.

The Commercial District

The Landscape.—The retail-stores section of the commercial district remains where it was located when the village of Negaunee was platted in 1865, along Iron Street. Iron Street extends from the Negaunee plain down across Partridge Valley to the north slope of Jackson Hill (Figs. 2, 3). This site was chosen for the retail section because of its strategic location near the junction of two railroads and in spite of the fact that the floor of Partridge Valley was a swamp. In times of heavy rains, the street formerly was blocked completely by running water, but a storm sewer now carries the water beneath the surface. One crosses the hidden stream without being aware of it. Nevertheless, the valley floor continues to be an unsatisfactory site. After the water table was lowered by the construction of the sewer, the wooden piles on which certain brick buildings were constructed began to decay. It was necessary to replace the piles with concrete (1925), and to strengthen the walls of the buildings with braces of iron. Southeast of the Iron Street section of the commercial district is the Pioneer Furnace section. Here piles of lumber, coal, and cement blocks dominate the scene and almost hide the remains of the old charcoal iron furnace.

Most of the business establishments in the commercial district are small retail stores which cater to ordinary household wants (Table V). No wholesale distributing is done except by one grocery store, which occasionally supplies some of the smaller stores in Negaunee with goods at wholesale prices. There is no establishment which is devoted primarily to collecting farm produce or to supplying farmers with tools, machinery, and fencing materials. On the other hand, displays of miners' clothing, lumbermen's

mackinaws and boots, fishing tackle, and hunting equipment occupy a prominent place in the windows of many stores.

The street scene is seldom very active. There appear to be no "rush" hours during the day, and the Saturday trade is only about twice that of any of the other days. The traffic on Iron Street is greater in summer than at any other season, for many tourists pass through the city, some of them stopping at the stores and restaurants. In autumn, one automobile, on the average, passes along the street every two or three minutes. In winter, street-cleaning activities are more in evidence than the traffic for which the streets are being prepared. With the aid of motor-driven snow plows and trucks, the snow is cleared from the street and hauled away.

TABLE V

COMMERCIAL AND MANUFACTURAL ESTABLISHMENTS
COMMERCIAL DISTRICT—1928

Type of Establishment	Number	Type of Establishment	Number
Groceries, clothing, general mdse.	29	Printing	1
Baked goods	3	Fuel and lumber	1
Soft drinks, ice cream, candy, pool rooms	6	Public utilities	2
Drugs	3	Restaurants	5
Jewelry, music	4	Hotels	2
Shoe repairing	2	Theatres	2
Tailoring	2	Banks	3
Laundry	3	Soft drink factory	1
Hardwood, furniture, plumbing, undertaking	11	Creamery	1
Blacksmith	1	Flour and grist mill	1
Garages	8	Glove factory	1
		Cigar factory	1
		Greenhouse	1
		Total	94

Dependence on the Mines.—The commercial district is dependent on the mines to a high degree, for most of its trade is carried on with people engaged in the mining industry. The smaller stores sell about 98 per cent of their goods to mine employees, and the largest dry goods store about 90 per cent, while the bankers, who serve the farmers over a fairly wide radius, depend on the mine employees for about 80 per cent of their

business. The remaining 2 to 20 per cent is with professional men, railroad employees, farmers, a few lumbermen, and the business men themselves. This dependence on mining accounts in part for the relatively quiet street scene; the miner and his family can purchase goods at any time they are needed. Although farmers from the surrounding area make the practice of purchasing supplies on Saturday, they are not sufficiently numerous to cause an important quickening of trade on that day.

The high degree of dependence on the mines is due to the overwhelming importance of mining in Negaunee, to the restricted, poorly developed farm area served by the city, and to the meagre resources of the lands somewhat more distant. Negaunee is practically a "one-industry" city, for all industries other than mining are of relatively negligible importance. The flour mill, which runs only part of the year, is operated by one man; the glove factory, though it has more than 100 employees, depends primarily on girls from mining families for its labor supply; and the creamery is a small one. Even if one considers the number of persons employed in stores as well as those in factories and mines, the dominance of the mining industry is scarcely less impressive. In 1919, the mine employees constituted 80 per cent of the men employed in mines, factories, and stores. These facts are sufficient to indicate the commercial significance of mining, but the trade relations of Negaunee merchants with areas beyond the limits of the urban complex require more extended treatment.

Farm Districts Served by Negaunee.—The small amount of out-of-town trade in comparison with local urban trade is due in part to the relatively restricted area occupied by farmers who sell their surplus products at Negaunee and buy their supplies there (Fig. 14).

This "service area" is limited by competing trade centers and by non-agricultural lands. Ishpeming, founded as a mining camp and supported by mining today (Fig. 14), lies next to Negaunee on the west, and effectively limits the service area on that side. Palmer, a mining center six miles south of Negaunee (Fig. 9), helps to determine the southern limit, and Marquette, thirteen miles east of Negaunee, tends to draw trade in that direction. Non-agricultural lands delimit the boundary on the northern, eastern, and southeastern margins. Almost no farm land lies in the ice-scoured hill country north of Dead River. Moreover, the river has been converted into an impassable barrier by the construction of the

Hoist reservoir (Fig. 14). The eastern boundary, about two miles from the city limits, coincides roughly with the edge of the more dissected portion of the Lake Superior escarpment. East and west of Goose Lake, are wooded, ice-scoured hills.

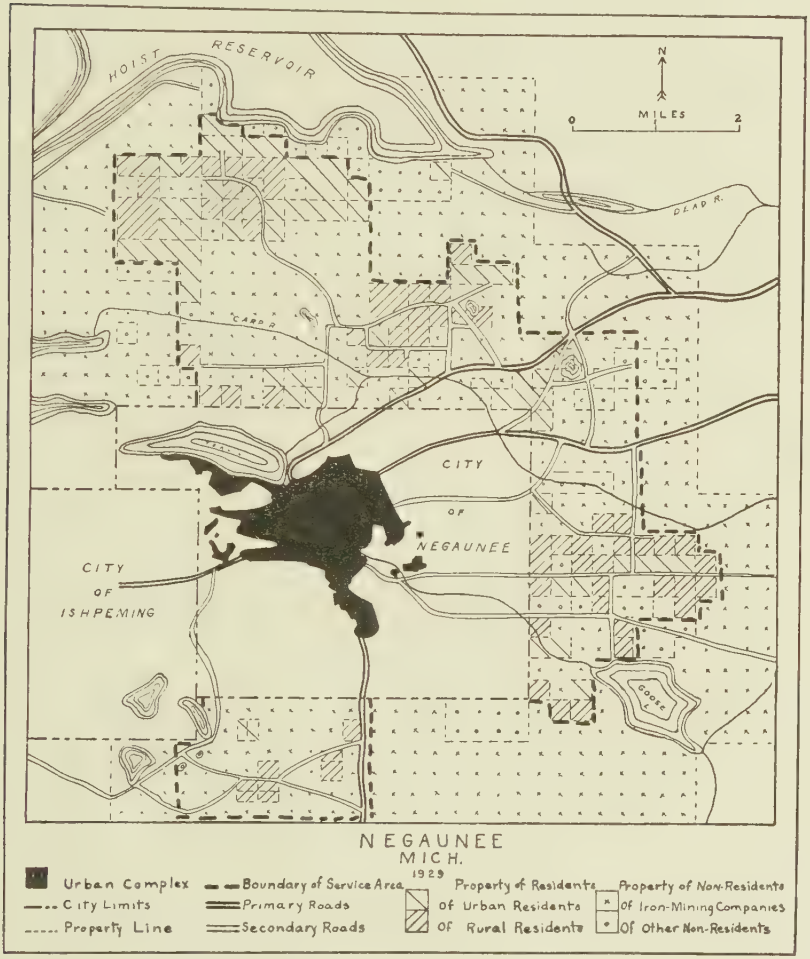

Fig. 14.

The low productivity of the service area is as great a handicap to a flourishing trade with the business men of Negaunee as is its small size. (1) The summers are relatively cool—too cool for corn—and the growing season is short. The average date of the

last killing frost in spring is June 8, and that of the first one in the fall is September 16. Moreover, killing frosts may occur in valley bottoms at any time during the intervening period. (2) The winters are long and snowy. Outdoor work is then difficult, and live stock must be sheltered and fed at least six months. It is therefore necessary to grow large quantities of forage crops if live stock farming is practiced. (3) A large part—more than half—of the tributary area is ice-scoured plain and hill country, non-agricultural at the present time. (4) The soils of the remaining area, though thick, are gravelly, sandy, or swampy. Even where the soil occupies well-drained flattish land, it is podsolic, and, therefore, characteristically infertile. (5) In addition to these handicaps, much of the land has a covering of stumps and of second-growth trees with which the farmer must contend. In 1917, it cost $45 per acre to prepare stump land for cultivation at the agricultural experiment station some miles east of Negaunee. Probably this is a conservative figure for most of the Negaunee area.

As a result of these natural handicaps, most of the land included within the service area (as outlined in Fig. 14) is not farmed, and the land occupied by farmers supplies meager quantities of produce for sale. Dairying is the dominant type of farming, though some attention is given to growing potatoes. Despite the importance of the milch cow in local farm economy there is no milk and only a very little cream shipped from Negaunee, so that there are no business men in the city who collect and ship dairy products. Part of the tilled land, perhaps a third, is cultivated by men who live in Negaunee. Because their crops, hay, potatoes, cabbage, and so on, are grown for their own use, the commercial district thereby loses trade instead of gaining it.

These small 40-acre farms, with perhaps 10 to 30 acres of cleared land apiece, handicapped by infertile soils and a short, cool, growing season, are not capable individually of supporting a family. Accordingly, the farm income is eked out by work in the mines and in more distant lumber camps. Indeed, farming in the Negaunee service area is so dependent on mining that many, perhaps most, of the men who retire from the mines seek out more productive lands in other parts of the Upper Peninsula.

Neighboring Urban Centers and the Forest Matrix.—The relative unimportance of Negaunee's out-of-town trade is due not only to the restricted extent and meager resources of its service

area, but also to the fact that very little trade is carried on with the neighboring urban centers and with the rural area beyond the limits of the Negaunee "locality." True, the largest meat market in Negaunee gets occasional orders from Ishpeming, and a greater number from Palmer, and the drug stores mail pharmaceutical supplies even to more distant points; but in the main, the neighboring urban centers, especially Ishpeming and Marquette, are more likely to invade the Negaunee market than to supplement it.

The communities of the Marquette Range, Negaunee, Ishpeming, and others, are set in a matrix of cut-over and second-growth woodland. Though this matrix serves various functions, as a source of hydro-electric power and firewood and as a hunting and fishing ground, it is an inert area commercially. It contains few farmsteads and few saw mills. Accordingly, it has almost no commercial value for the business men of Negaunee, save in its functions as a playground. Small as the trade with such an area must be under any circumstances, Negaunee is severely handicapped in tapping it, for better roads lead from Ishpeming and Marquette into the "woods," and both of these larger cities have hotel accommodations superior to those obtainable in Negaunee. Thus they tend to be nodal points from which roads and trails radiate into "Hiawatha Land."

Overdevelopment of the Commercial District.—Fifteen vacant store buildings and nearly as many converted into garages testify to the fact that the trade of Negaunee is not so large as it once was. This condition is due in part to a decrease of 22.5 per cent in the population of Negaunee within the last two decades, and in part to the invasion of its trade area by merchants of Ishpeming and Marquette. In days past, "Negaunee people bought in Negaunee," and "a town's trade was its own." Two developments have changed this—the automobile and the chain store. The drive of three miles to Ishpeming and of thirteen miles to Marquette is not thought too far to go for groceries and dry goods if one owns a car. Furthermore, chain stores at Marquette and Ishpeming carry larger stocks of goods at lower prices than do the Negaunee merchants.

Manufactural Areas

General Character.—The manufactural activities of Negaunee reflect the poverty of the surrounding countryside and the dominance of mining in the life of the city. Like the occupants of the

farms, the factory employees are too few to be an important element in the commercial activities of the city. The factories, all small, occupy buildings originally planned for stores, so that they differ but little in outward appearance from those used solely for retail purposes. With one exception, the factories are dependent on the local market, and they all use raw materials a large part, if not all, of which is shipped into the Negaunee area. The soft drink plant, the three bakeries, and the cigar factory (employing 2 men) clearly market their products locally. There is no artificial ice plant, for ice harvested from Teal Lake supplies the city. The lumber company, though it formerly operated a flooring mill, now does retail business only. Three plants—the flour mill, the creamery, and the glove factory—are sufficiently distinctive to receive more extended notice.

The Flour and Grist Mill.—This mill was installed by a co-operative organization of Finnish farmers in a building formerly used as a brewery. When it proved unprofitable, all of the farmers withdrew from the organization save about five men. The mill is now operated about two months each autumn, and only one man is required to run it. Many farmers in this part of the Upper Peninsula own small grist mills, so this plant is engaged chiefly in making barley flour. About 80 farmers have some grinding done there each year, though most of them live outside of the regular Negaunee service area.

The Dairy.—The dairy, though located in Negaunee, is drawing its raw material from a comparatively wide radius and selling its product in all three of the larger cities of the Range—Ishpeming, Negaunee, and Marquette. It is primarily related to two conditions —the presence of a good market for dairy products in the mining towns and in Marquette, and the development of dairy farming in nearby parts of the Upper Peninsula. Most of the milk comes from within a 3-mile radius of Negaunee, but cream is shipped in by rail and truck from points as many as 50 miles away. The creamery thus reaches beyond the limits of the Negaunee service area to richer agricultural districts.

The Glove Factory.—The glove factory is a "parasitic" industry, for as already noted it depends on the daughters of miners for its labor supply. Through the influence of the local Chamber of Commerce, the concern was induced to locate in a long-idle building adjacent to one of the railroads. In seeking an occupant for the building (1923), the Chamber of Commerce refused to

consider any industry that might draw labor from the mines. In 1929, the factory was employing 103 girls to sew gloves and 25 men (really youths, several of them of high school age) to tend the cutting machines and do odd jobs. The girls earn from one to two dollars a day. The isolation of Negaunee is counterbalanced in part by the fact that both the raw material and the finished product are of relatively high value in proportion to bulk and weight. Leather is received from Chicago, and the gloves are sent to various parts of the country. The cost of fuel to heat the cutting boards is negligible. The sewing machines are electrically driven, but the cost is too slight to make this a significant item. The chief attraction in Negaunee for an industry of this kind is clearly the presence of cheap labor.

The Peri-Urban Pastoral and Agricultural Districts

Significance.—Surrounding the urban complex is a pastoral-agricultural zone, varying in width from a few yards to more than a mile (Figures 1 and 2). The zone is significant in this study of Negaunee because it was cleared by inhabitants of the city and is used by them, and because it reveals the agricultural possibilities of the Negaunee service area.

Distribution.—The distribution of crop and pasture land in the peripheral zone is determined primarily by the distribution (1) of commercial, residential, and saxicultural land in the urban core, (2) of swampy, steep, and ice-scoured land, and (3) of flattish land with thick, well-drained soils.

(1) The commercial and residential districts have occupied land otherwise suitable, for the most part, for crops and pasture. As a result the hay and pasture zone assumes a circular form, surrounding these districts. Mining has also operated in this negative way by appropriating certain areas, thus removing them from agricultural or pastoral use, but its influence has been positive as well as negative. In general, the surface used in mining had to be cleared of its forest growth. If and when abandoned, such land became available for grazing, and, in some places, for crops. The coincidence of the outer limit of the crops and pasture zone south and east of the city (Figure 2) with the outer limit of abandoned mine land illustrates this relationship. Only where caves and pits have made the land unfit for grazing has the forest crept back slowly over the abandoned area cleared for mining.

(2) The poorly-drained, steep, and ice-scoured lands (Fig. 10) have been avoided in locating residences. They have been available, therefore, for pastoral use unless preempted by the mines.

(3) Flattish or gently sloping land with thick, well-drained soils, if near the urban complex but not occupied by it, have been cleared even though not in demand for mining. The two examples of this type of land are the district southwest of Jackson Hill, and the northern part of the Negaunee plain. The latter has been an important agricultural area since the sixties of the last century.

Pastoral Occupation of the Peri-Urban Zone.—A notable feature of the spring, summer, and autumn landscape is the milch cow, which, singly or in herds of ten to twenty, wanders along the roadways, grazing wherever an inviting, unfenced area can be found. In the City of Negaunee there were 275 owners and more than 640 cows, four years ago.[80] The city "pound" has sometimes held more than a dozen cows which the constable "arrested for vagrancy," and one over-zealous official is said to have had about a hundred cows in the pound at one time.

The prominence of the milch cow is due to an effective combination of natural and cultural conditions.[81] (1) There is a large proportion of the peri-urban zone available for summer grazing because it is unfit for tillage. (2) Cool, humid summers permit a surprisingly luxuriant growth of grass, which is available for pasturage and for hay. (3) The surrounding cut-over and second growth woodland has some grazing value. (4) The irregular, scattered distribution of the locations is such that each of them is in reach of grazing lands. (5) The rent for most of this land is low, or else no rent is charged at all. (The mining companies think it good policy to encourage the miner to keep a cow and to tend a garden.) (6) The miner's social status has not made him in most cases "superior" to the manual labor involved in feeding, sheltering, and milking a cow. (7) The cow furnishes an important addition to the miner's income—an addition that is particularly needed if for any reason the miner is working only part time.

Although milch cows are still numerous, there has been a significant decrease in their number. Within the last four years,

[80] R. L. Walker, County Agricultural Agent, Personal Communication.

[81] Reconnaisance work in other mining areas of the Upper Peninsula has led to the tentative conclusion that Negaunee is typical, rather than exceptional, in the number of cows.

the number of cows has decreased from more than 640 to 335, and the number of owners from 275 to 132. A similar change has taken place in every other mining town on the Marquette Range. The following reasons for this decline appear to be the more important ones: (1) There is a growing disinclination to keep cows, a result of "second generation" pride. (2) In late years, the price of feed has been high, and that of milk low. (3) Recent years have witnessed the increasing use of automobiles, which have made the highways somewhat unsafe for wandering cows and have tended to usurp the place of cows in the domestic economy of the miners. As a result of owning an automobile, the miner may have little or no money with which to buy and keep a cow. (4) Another factor—in Negaunee at least—has been the restriction of the grazing area. "People are more particular than they used to be," and object strenuously if wandering cows damage their lawns. Furthermore, the caving of the land between the Maas and Negaunee mines has destroyed the value of that area for grazing purposes.

The long, snowy winters make the high price of hay and other stock food a critical matter. Though the sale of imported hay is relatively large—over a hundred customers in Negaunee buy hay each winter from the largest of the general stores—the difficulty is met, in part, by growing hay and oats on the better lands in the peri-urban zone.

Agricultural Occupation of the Peri-Urban Zone.—Most of the land in the zone between the urban complex and the edge of the surrounding forest is more suited to pasturage than to crops. The poorly-drained land, as near Partridge Creek and on the borders of Teal Lake, would require expensive drainage before it could be tilled. No amount of improvement short of terracing the slopes with stone walls and with soil carried up from the valleys would make the rock knobs arable. Their slopes are generally steep, 10 degrees or more, run-off is rapid, and soil is thin or absent. In addition, the surface is commonly roughened by small ice-plucked pits. The steeply sloping moraine, commonly found at the base of ice-scoured knobs, is strewn with crystalline boulders and the texture of the soil is that of gravelly sand. No attempt is made to use this type of land for crops. The steeply sloping outwash, found along Teal Lake Hill (Figure 10) and east of Teal Lake, is so sandy and steep that drainage is too rapid. Though used for hay to some extent, these lands are more commonly grazed. To these

naturally unfavorable land forms, one must add those created by man—pits, caves, rock piles, abandoned roadways, railroad cuts and fills, all about as permanent as some of the natural features just listed, and certainly as effective in hindering crop production.

The non-agricultural character of these lands is seen in the fact that they are not used for crops despite a keen demand for crop land near the city. The milch cows must be provided with hay for a large part of the year. There is also considerable need for garden sites: the residential areas are so widely scattered that most of the inhabitants are close to lands not occupied by dwellings or mines; the mining companies have encouraged gardening by letting the land rent free and by giving prizes for the best kept gardens; and the miner has some time, often a day to two each week, in which to cultivate his garden. If his time is fully taken up at the mine, the garden can be cared for by his family. Although this demand for crop land has not brought about agricultural use of the unfavorable areas listed above, it has caused rather thorough occupation of the suitable land.

The gently sloping morainal land near Cornishtown is all cultivated. A similar strip of moraine southeast of the urban complex is in crops each year. The boundaries of these cultivated areas are almost if not quite coincident with the boundaries of the land form occupied. The largest area of cultivated land is found on the flattish outwash plain, east of Teal Lake. It will be remembered that all the plain east of the Pioneer plat was originally divided into small farms. Bounded on the north by barren quartzite hills, on the south by a low bluff overlooking the Partridge valley, and on the east by a 100-foot terrace face (a boulder-strewn strip of moraine), the area divided into farms exceeded 500 acres. Gradually the encroachment of mines and residences has restricted the cultivated area to about one-fifth its original extent.

The needs of the city and the climatic and soil conditions are reflected in the crop association. Oats and hay furnish food for milch cows, and thrive in the cool, relatively humid summers. Potatoes, a common food staple and easily grown, are perhaps as tolerant of the sandy soil as any other crop that might be grown. During droughts, however, the crops on the outwash plain suffer, for the gravelly subsoil permits rapid underground drainage, and the low water table, due to pumping at the Maas and Negaunee mines, prevents the rise of capillary water. The gardeners com-

plain of the dry soil, and assert that for it to produce good crops there should be some rain every day.

The failure of the peri-urban zone to encroach on the surrounding woodland is not because the soil of the woodland is less fertile, for such is not the case; it is due rather to the cost of clearing land which is not sufficiently productive to bear the expense of removing the trees, underbrush, and stumps, and to rapidly decreasing demand for pasture and garden land with increasing distance from the urban complex. The conclusion is forced on the observer that it is the demand of the population for garden, crop, and pasture land *near* the city that causes the peri-urban zone to be so used.

The extent and conditions of utilization of the zone verify the conclusions already reached concerning the agricultural handicaps of the Negaunee service area. This larger area has practically the same handicaps as the peri-urban zone, without the advantage of a keen demand for crop and pasture land. It is no wonder that only the better lands along roadways are occupied by farmers, and that practically all of them must eke out the farm income with work in the mines and lumber camps.

The Transportational Areas

The Road Pattern.—The primary highways which serve Negaunee were located to connect the mining centers with one another and with Marquette, the secondary highways to lead from these centers to outlying mines, lumber camps, resort camps, and farms.

The trunk of the system of primary highways extends from Marquette westward beyond Michigamme (Fig. 9). At Negaunee, a branch extends to Palmer and Gwinn (both mining towns), continuing southward toward Lake Michigan ports. At Humboldt, a second branch runs southward to Republic (mining town) and on to Iron Mountain (also a mining center). From Michigamme, the main highway leads northwestward to the copper-mining centers on the Keweenaw Peninsula.

The net of secondary highways focusing on Negaunee is small and decidedly asymmetrical with respect to its focus, and the meshes of the net are of different sizes and shapes (Fig. 14). Because of the presence of hills on the north and south sides of Negaunee and because of the location of Ishpeming on the western margin, the secondary highways focusing on Negaunee lead eastward. Most if not all of these roads were originally located to reach

logging camps. Today, they serve scattered resort camps and farmsteads.

The road pattern shows little regard for section or township lines. The topography, hilly and with much swampy land, makes it far more expensive to build straight roads than curving ones. Furthermore, the fact that the area crossed by the roads is mostly woodland rather than closely settled farm land has made it easy for the road builder to ignore section and quarter-section lines.

The road pattern of the urban complex (Fig. 2), like the pattern of the primary highways serving the city, reflects the attraction of the mines and the difficulties imposed by a hilly, poorly-drained terrain. Iron and Main Streets, modifications of the old Plank Road (which connected Jackson mine with Marquette), form two base lines to which most of the streets in the platted portions of the city have been made to conform. The roads outside of the platted area lead to the mines. The necessity for avoidance of pits and caves, as well as swampy valleys and barren hills, has caused many of the roads to be tortuous in plan.

Road Construction.—Although road building in and near Negaunee has been handicapped by a difficult terrain, the roads are in excellent condition. The lack of farm settlement has made it possible to keep the mileage of roads per unit area relatively low, and taxation of the mineral wealth of the City and County has furnished funds for constructing streets and primary highways of concrete and bituminous-macadam. The secondary roads are narrow and surfaced with loose gravel, but they carry little traffic and therefore are subjected to little wear.

Another factor in the maintenance of good roads is the abundance of road materials. At the city quarry in western Negaunee, greenstone is blasted from the face of a cliff and crushed for use in building roads. The outwash along Teal Lake Hill and the outwash plain of east Negaunee contain large amounts of well-sorted gravel, now worked at several pits. A third source of road material is found in the numerous piles of waste rock which dot the landscape. Though not as satisfactory as crushed greenstone for use on roads subjected to heavy traffic, this material does not require crushing and "binds" better than greenstone. It appears to be less used than formerly, probably because it coats the vehicles and even their occupants with brick-red powder, the unmistakable stamp of the Iron Country, and because it does not furnish a durable surface for motor traffic.

Road Traffic.—The traffic on the primary highways leading to and through Negaunee is relatively heavy. On each of the two Marquette roads, 10 to 20 automobiles pass each hour, save in winter, and on holidays the roads resemble busy city streets. The road to Ishpeming carries two to three times as much traffic as either of the Marquette roads. It is evident at a glance that most of the travelers are urban dwellers, many of them tourists. The necessity for interurban communication and the desire on the part of tourists and townspeople to drive along these wooded, even picturesque ways, are the principal motives for using these roads.

In contrast to these main highways, the secondary roads generally appear about as idle as the land they cross. Almost all of them are "blind alleys," for they either end or become impassable for motor traffic a few miles from the city. Accordingly, they are used almost exclusively by the few farmers who live in the Negaunee service area, and by city dwellers who have camp sites or small garden plots scattered here and there in the forest.

A third group of roads is also characteristic of Negaunee—the decadent roads leading to idle or abandoned mines (roads near mines "10," "11," "17," in Figure 2). These curve around hills, and past pits, crumbling foundations, and even pieces of broken machinery. The presence of numerous cuts and fills and the absence of vegetation on their stony surfaces enable the observer easily to trace their winding courses.

The Railroad Pattern.—The pattern of the railroads serving Negaunee and other urban centers on the Marquette Range is strikingly similar to the pattern of the primary highways (Fig. 9). Three railroad lines extend westward from Marquette to Negaunee and Ishpeming. Two of the lines end a few miles west of Negaunee, while the third continues to the west end of the Range (at Michigamme) and beyond. Running from the west end of the range eastward to Negaunee, and thence southeast past the Gwinn mining district, is a line which leads to Lake Michigan ports. A short line also reaches south from Negaunee to Palmer. Two other southern branches, one to Republic and the other to Iron Mountain, complete the net, which, like the primary highway net, clearly reflects the geographic unity of the mining towns and the shipping ports.

The railroad pattern within the Negaunee urban area is closely meshed, occupying a surprisingly large proportion of the land (Fig. 2). The railroads cross and recross one another, sending off short

spurs at irregular intervals. This pattern, not unlike a tangle of roots feeding a few main stems, is due to the presence of the iron mines. The mines have attracted four main lines, each of which has thrown out spurs to reach as many of the mines as possible.

The idle railroads and abandoned railroad beds which lead to idle and abandoned mines are an important part of the railroad net. One finds the greater part of these decaying roadways along the southern and eastern sides of the city.

Railroad Traffic.—The railroad traffic reflects (1) the insufficiency of the Negaunee service area as a source of foodstuffs, (2) the lack of manufactures of note, and especially (3) the presence of the iron mines. Although it is not possible to secure complete data on rail traffic in and out of Negaunee, it is well established that iron ore is the only important commodity shipped out of the city, and that foodstuffs, manufactured goods, timber, and coal constitute the bulk of the imports.

(1) The low productivity of the farm districts tributary to Negaunee is in part responsible for the lack of agricultural exports and for the importance of agricultural products among the imports. Despite the fact that dairying is the dominant type of farming, no milk or cream is shipped out of Negaunee, save a can or two each week. To maintain the production of milk consumed locally, hay is obtained from the Hay Belt on the lacustrine plain north of St. Ignace. Grain for stock food comes from the Iowan portion of the Corn Belt, and flour for human consumption from Minneapolis. Sugar comes by rail from New York, or rail and barge from New Orleans.

(2) Except for the importation of leather for the glove factory and the exportation of gloves, the traffic in manufactured goods consists of imports to meet the needs of the local market. Negaunee is so located as to draw these commodities from three metropolitan areas, Minneapolis-St. Paul, Chicago, and Duluth. Each city is favored by freight rates on one or more articles, so that Negaunee must be considered as lying in a common feeding ground. Even though complete data on the railroad traffic of Negaunee were available, the magnitude of the Negaunee market for manufactured goods—and for foodstuffs, too—would not be adequately indicated because of the relatively large receipts by truck from wholesale houses in Marquette and Ishpeming.

(3) The iron mines create a demand for logs, make it possible to import coal more cheaply than would otherwise be the case,

and supply the railroads with their principal commodity. Most, if not all, of the timber being used in the mines is cut about 100 to 150 miles east of Negaunee. Coal is brought from the Appalachian fields. The cost of shipping a ton of coal from the coalfields to an Erie port, thence by an ore boat to Marquette, and on to Negaunee by rail, is little more than half the cost of the all-rail haul from the Illinois coal mines.

The transportation of iron ore is handicapped by the fact that it is a seasonal one-way traffic requiring special cars. The shipping season is limited to a six months' period by two requirements—open navigation on the Great Lakes and average daily temperatures above freezing (so that the moisture in the ore will not freeze). The cars lie idle the rest of the year. The lack of a return load for the cars forces the ore to bear the cost of hauling them back to Negaunee. Special steel cars with a capacity of 50 tons each are used. Tending to offset these disadvantages is the ease with which the ore is moved down grade to the docks at Escanaba and Marquette. The Marquette route, along which 95 per cent of the ore moves, is particularly steep. As a result of the steep grade between Negaunee and Marquette, the return load of empty cars determines the size of the loaded train. On the Duluth, South Shore and Atlantic road, the up-grade limit is 65 empty cars, so that the usual load down to port does not exceed that number. For the Lake Superior and Ishpeming line, the limit is 50 cars.

Bulkbreaking at port has been reduced to a remarkably rapid process.[82] The average time elapsing between the arrival of an ore boat and the completion of loading (including all delays) was 54 minutes per 1000 tons of ore in 1928, compared with 296 minutes in 1899; and the time actually used in loading was 32 minutes per 1000 tons in 1928, compared with 88 minutes in 1899. Despite these economies, the bulkbreaking charge is 10 cents per ton, or about one-fifth of the transportation charge from Negaunee to the Marquette docks.

Whether the ore moves to Marquette or to Escanaba is determined by its ultimate destination—whether to the Lake Erie ports and inland cities served by them, or to the Chicago district. The fact that 95 per cent of the Negaunee ore moves through Marquette to the Erie ports is due primarily to four conditions.

[82] Harris, H. R., "Transporting Ore from Mine to Docks," Reprint from the *Mining Congress Journal*, October, 1929.

(1) The eastern market is larger. (2) Freight rates have been so adjusted that the rate from Negaunee to Chicago is the same as that from the mines of Menominee Range; on the other hand, the rate from Negaunee to the Lake Erie ports is less than that from the Menominee or any other iron range in the Lake Superior region. (3) The Lake Superior and Ishpeming railroad is owned by operators who produce nearly 90 per cent of the ore mined in Negaunee. It is their practice, as a matter of course, to route the ore over their own road if practicable. (4) All of the mines now operating in Negaunee are affiliated with iron and steel manufacturers in Ohio and Pennsylvania. These manufacturers take a large part of the Negaunee ore.

IV. Aspects of the Political Geography

The City[83] *of Negaunee*

The total area contained within the limits of the City of Negaunee is 6.5 times as large as the urban area (Fig. 14); the urban complex covers 2.3 square miles, whereas the City includes 15 square miles. The boundaries of the City have not been located with respect to the commercial and residential areas. Instead, the general location of the lines has been determined by the desire to include all of the mineral land near the urban area, and their exact location by the position of the section and half-section lines.

The tendency of urban units in mineralized regions to include the ore-bearing lands is a common one in the Upper Peninsula. It manifests itself in one of two ways; either the city limits are expanded to include much land that is in no sense urban but that does or some day may pay taxes on the underlying mineral wealth, or, if the mineral lands are clearly too extensive to be annexed to the city, the township form of government is retained, with the result that the urban center depends on township taxes to support its schools and build its roads. In selecting the *city* rather than the *township* type of organization, the inhabitants of Negaunee doubtless were influenced by the relatively compact grouping of the mines near the urban nucleus.

The southern and eastern boundaries were located about two miles from the center of the urban area, thereby including all of the known ore bodies in those directions. On the north, there was little incentive to include much land because ice-scoured hills, containing no ore and unsuited to residential use, occupy the area north of Teal Lake. Accordingly, the boundary was made to coincide with the section line nearest the urban area. A northwestern extension of the City (Fig. 14) was made in order to include all of the Lillie-Cambria mining district, but the neighboring City of Ishpeming was able to hold the greater part of the western boundary

[83] In the preceding chapters, "city" is used as synonymous with "urban complex"; the terms "City of Negaunee" and "City" are reserved for the political unit.

of Negaunee relatively close to the center of its urban area. As a result of the operation of these factors, the urban area lies somewhat north and west of the center of the City.

Municipal Functions

Among the more important municipal functions of geographic interest are (1) the maintenance of adequate school buildings and grounds, (2) the construction and maintenance of roads, (3) the provision of an adequate water supply, and (4) the establishment and maintenance of public parks and playgrounds.

(1) The public school equipment reflects the presence of the mines in several ways. (a) The relatively large taxable assets of the City have made it possible to provide excellent buildings and equipment. Three large brick buildings occupy a prominent place in the Main Street section, and eight smaller ones are located in other parts of the City. (b) The presence of many foreign-born miners has created a need for adult education. Evening classes in English, history, and other subjects are conducted for the benefit of any adults who care to attend them. (c) The fact that many of the pupils will find their life work in the mines has made it important that they receive vocational instruction. One of the larger school buildings is used exclusively by classes in woodturning, forging and other phases of manual training.

(2) The roads of Negaunee reflect the large taxable resources of the City more faithfully than do the school buildings. In response to the demand for motor highways and well paved streets, the yearly expenditure for road construction and maintenance grew from $25,000 in 1911 to $100,000 in 1926. Perhaps these broad, concrete and bituminous macadam roads are more effective than any other features, save the well-kept homes, in creating an atmosphere of prosperity and permanency which so commonly is lacking in mining towns. To keep the roads open for motor traffic in winter, snow is hauled away from Iron Street, and snow fences are erected at places along the main highways leading to the City. Sidewalks are cleared of snow with shovels and horse-drawn plows. The yearly cost of handling the snow is about one-fifth of the total outlay on roads.

(3) Prior to 1882, Negaunee had no municipal water supply. Hogsheads placed to catch the run-off from the roofs of houses, cisterns constructed for the same purpose, and wells dug in the

glacial drift were the only sources of water. With the growth of the City and the development of mining a new source of water became necessary. Danger of pollution became greater, the demand for water increased, and the ground water supply began to fail. By 1880, the wells in the "entire western part of the city" had "gone dry." [84] This was attributed to the lowering of the water table by pumping at the Jackson pits.[85] There is said to be only one well in the urban area today.

The inhabitants turned to Teal Lake, which promised an unfailing supply of pure water. Covering 543 acres, with an average depth of 28 feet, the lake constituted an excellent reservoir within a relatively short distance of the heart of the city. A pumping station was erected in 1882, a slaughter house was removed from the eastern shore of the lake, and all use of the lake for recreational purposes, boating, swimming, and fishing was forbidden. Although near the center of the urban area, Teal Lake drainage basin included no residential districts except the Cambria location. Teal Lake Hill forms a water parting, effectively preventing the run-off from most of the urban area from reaching the lake. In addition, the western and northern parts of the drainage basin were wooded hills, unoccupied by farmsteads. Pollution by drainage from the mines in or near the basin has been guarded against, also. The water pumped from the Cambria-Hartford mines is conducted by a wooden aquaduct across a low saddle in Teal Lake Hill to the Partridge Creek basin, and the drainage from Maas mine flows into the outlet of Teal Lake.

The lake appears to have been a satisfactory source of water until recent years. A slight but steady lowering of the lake level between 1909 and 1922 (1.45 feet) [86] aroused two fears—that the pumps would have to be lowered in order to function properly, and that the lake would in time become inadequate as the sole source of the municipal water supply. Further, an increase in the number of dwellings along Teal Lake Road had increased the danger of pollu-

[84] *Negaunee Iron Herald,* Dec. 16, 1880 (Reprint).

[85] The statement of a Negaunee citizen that "wells always go dry in a mining district, though it may take some time to happen" sets forth a principle many illustrations of which are found in the Upper Peninsula.

[86] The level of the lake continued to drop, reaching its lowest level in 1925 when it was 8.32 feet below that of 1909. By 1929, the level had mounted until it was 1.86 feet *above* that of 1909. These changes appear to have been due primarily to changes in rainfall.

tion. The move to develop a new source of water received particularly hearty support from a group of citizens who, in addition to their concern for a safe, dependable water supply, were hoping to use Teal Lake for recreational purposes. It was expected that the State Board of Health would permit boating and bathing if some other source of water could be substituted for Teal Lake. "What restoration of the recreation privilege on Teal Lake would mean can scarcely be conjectured, after these many years' denial," commented the local newspaper. Undoubtedly, the lake would become a popular resort center, for, besides its attractive setting, it has a sandy beach at the east end, it is on a primary highway, and it is the most attractive of the lakes near Negaunee, Ishpeming, and Marquette for bathing. Lake Superior is too cold for all except the most hardy bathers.

All attempts to find another water supply have thus far failed.[87] In 1922, three wells were sunk near the eastern end of Teal Lake. The water was soft, but the fine sand (a "quicksand") into which the wells were drilled yielded relatively little water, and promised to be so destructive of the pumps that the project was abandoned. Infiltration galleries were then constructed, but they failed to yield more than a small part of the water which the city requires. These two attempts cost the City of Negaunee about $170,000, or $22.50 per capita.

Although the lake level is now high enough to remove all concern for the near future, a third experiment is planned for 1930. Wells are to be sunk in the Carp River basin north of Teal Lake, about four miles from the urban area. This project, if carried out, will require a storage basin on Teal Lake Hill.

(4) Although there are many picturesque landscapes in Negaunee—Teal Lake and its shores, for example—only one of the three recreational grounds of the City possesses any natural charm. An outdoor rink at the west end of the Iron Street commercial section occupies an area which would be idle otherwise. The school playground and ball park are located on an artificially drained portion of the flattish plain southeast of Teal Lake, but the lake is hidden from view by a high board fence. The public tourist

[87] A plan to maintain the level of Teal Lake by leading the water pumped from the Maas mine into the lake was abandoned when the State Board of Health declared the mine water unsafe. (At Iron Mountain, the level of Lake Angeline, which supplies the city with water, is maintained by water pumped from the workings of the Chapin mine.)

park, on the south side of Jackson Hill, is well shaded by maple trees, and protected from north winds by the jagged, ice-plucked cliff which here forms the southern slope of the hill. These three small areas are the only public recreational grounds in Negaunee.

The lack of municipal parks is due, in large part, to the fact that there is little need for them. The pasture land and idle land near the scattered residential districts afford play space for children, and both children and adults utilize the woodland which surrounds Negaunee. Deer hunting, snow shoeing, and ski-jumping, trout and lake fishing, and motoring—each in turn engages the attention of many of the inhabitants as the seasons change, and each is dependent on the presence of great stretches of cut-over and second growth woodland near the city, a natural playground which no city park could possibly rival.